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ABSTRACT

A study examined the effects of verbal and perceptual dimensions of individual differences in relation to the efficacy of two different kinds of modeling procedures in the acquisition of a teaching skill (analytic questioning). Aptitude tests for cognitive factors plus specially developed audiovisual tests were administered to 121 intern teachers randomly assigned to three treatment groups: a film-mediated modeling treatment (a filmed portrayal of analytic questioning); a written modeling treatment (a text of the film sound track); and a control treatment which received no model, but went through all other steps including initial instructions and microteaching pretest and two cycles of models, rehearsal, and microteaching. The criterion performances assessed by trained raters included the frequency, variety, and quality of analytic questions used in three separate teaching sessions in addition to scores on two written posttests. Instructional treatment main effects as well as aptitude by treatment interactions were investigated using analysis of variance and comparison of regression slopes. Findings, which supported hypotheses, suggest that the rate and level of learning of a specific teaching strategy varies as a function of model presentation (film-mediated modeling most effective: no modeling least effective); and that the effectiveness of instructional methods varies from S to S with such differences being related to trainee aptitudes. (ED 017 985 and ED 028 982 are related documents.) (JS)

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THE EFFECTS OF INDIVIDUAL DIFFERENCES ON OBSERVATIONAL LEARNING IN THE ACQUISITION OF A TEACHING SKILL

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Stanford, California

March 1969

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Mary Lou Koran

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SUMMARY

The purpose of this study was to examine the effects of verbal and perceptual dimensions of individual differences in relation to the efficacy of two different kinds of modeling procedures in the acquisition of a teaching skill. The two different methods of presentation employed were written and film-mediated models. Both modeling treatments were expected to produce greater behavior change than a control treatment. It was anticipated that for _S_s receiving the film-mediated model, criterion scores should show stronger relation to perceptual abilities, while for _S_s receiving the written model, criterion scores should show stronger relation to verbal abilities. These hypotheses imply that there are nonparallel regression slopes, and consequently, that one treatment will not be superior throughout the distribution of perceptual and verbal ability variables.

Specific predictions, though tentative, were based on theoretical considerations which suggested that the requirements of the Written and Film-Mediated Modeling treatments were sufficiently different to produce different ability-performance relationship. These predictions were derived from an analysis of learning tasks and processes corresponding to a theoretical model proposed for the investigation of individual differences in learning.

Following the administration of aptitude tests ~~selected~~ from the French Kit of Reference Tests for Cognitive Factors and from a series of specially developed audio-visual testing materials, 121 Stanford intern teachers were randomly assigned to three treatment groups: a Film-Mediated Modeling treatment, consisting of a filmed portrayal of Analytic Questioning, the teaching skill to be learned; a Written Modeling treatment consisting of a verbatim text of the sound track from the film-mediated model; and a Control treatment which received no model, but went through all other steps common to the two modeling treatments.

Treatment conditions were held constant in all ways except for the mode of model presentation. In terms of general procedures all Ss received the initial instructions and microteaching pretest followed by two cycles comprised of models, rehearsal and microteaching. Treatments were terminated with the completion of two written tests. The criterion performances assessed included the frequency, variety, and quality of Analytic Questions used upon three separate teaching sessions in addition to scores on the written measures.

Instructional treatment main effects as well as aptitude × treatment interactions were investigated. Analysis of variance was used to test treatment effects. These analyses disclosed highly significant treatment effects in which _S_s in both Written and Film-Mediated Modeling treatments generated significantly higher frequency, variety and quality of Analytic Questioning than did Control group _S_s. Similarly, _S_s in the Written and Film-Mediated Modeling treatments performed significantly better on both written measures than did Control group _S_s. Moreover, from the average data alone, training under Film-Mediated Modeling conditions appears to have been consistently more effective than training under Written Modeling conditions across all measures of the dependent variable.

Aptitude × treatment interactions were evaluated by comparing regression slopes for different treatments. Analyses of interactions disclosed that scores on Hidden Figures, Maze Tracing and Film Memory tests interacted significantly with the instructional treatments. In addition, the magnitude of these interactions tended to increase across performance trials. Interpretations of these interactions were derived within the framework of the theoretical model described.

These findings suggest that the rate and level of learning of a specific teaching strategy varies as a function of model presentation; and that the effectiveness of instructional methods varies from *S* to *S* with such differences being related to trainee aptitudes. Results such as these, if replicated, may provide a basis for the individualization of teacher training programs.

CHAPTER I

THE PROBLEM

Definition of the Problem

The fields of education and psychology abound with questions related to the attainment of learning proficiency through variations in materials and tasks, instructional techniques, and abilities of the individual learner. There are also the more complicated questions of the degree to which learning effectiveness is a function of the interaction of these variables.

Investigations of learning under different instructional procedures commonly assign Ss randomly to multiple treatment conditions and compare average performance on some criterion measure. The usual conclusion has been that one of the treatments is more effective than others in some general sense. However, the meaning of main effects is altered in the presence of interactions, and variables not represented have no opportunity to demonstrate their interactive effects (Snow, Tiffin, and Seibert, 1965).

Investigators have often looked for aptitude variables to serve as general predictors of criterion scores, but this tends to focus attention on aptitudes that correlate with outcome under almost any treatment rather than on those likely to be involved in aptitude × treatment interactions. Predictors having low or negative correlations with success under certain treatments have been largely disregarded, even though these variables may be of considerable importance when instruction is adapted to the individual (Cronbach, 1965).

As Cronbach (1957) has argued:

> Applied psychologists should deal with treatments and persons simultaneously. Treatments are characterized by many dimensions; so are persons. The two sets of dimensions together determine a payoff surface (p. 680) . . . Ultimately we should design treatments not to fit the average person, but to fit groups of students with particular aptitude patterns which correspond to (interact with) modifiable aspects of the treatment (p. 681).

Gagné (1964) also has suggested that individual differences in the learner are among the most important independent variables as one proceeds to the more complex forms of learning. To this extent he was supporting the Cronbach argument for simultaneous consideration of aptitude and instructional variables.

One complex form of learning in which the role of individual differences might be studied is that of observational learning. The wealth of literature surrounding observational learning (Bandura and Walters, 1963; McDonald and Allen, 1967) indicates the educational significance of studying learning efficiency in association with modeling procedures. Research in this area has consistently shown that complex social responses and teaching skills may be acquired or the characteristics of response hierarchies may be considerably modified as a function of observing the behavior of others and the consequences of their responses, without the observer performing an overt response himself, or receiving any direct reinforcement during the acquisition.

While Bandura and Walters (1963) have suggested that observer characteristics influence the extent to which observational learning occurs, observer characteristics have been largely disregarded in previous research. Thus a study of the relationship between individual differences and the efficacy of different modeling procedures, while exploratory, contains elements of potential importance for evaluating the factors influencing learning efficiency when modeling procedures are used in teacher training programs.

Related Theory and Research

Observational Learning

A common approach to the transmission or modification of teaching skills has been to provide teacher trainees with some type of written or oral instruction followed by periodic feedback on their attempts to produce these behaviors in the classroom. An alternative to this strategy of teacher training is suggested by recent findings on the role of observational learning in personality development and behavior modification. Bandura and Walters (1963), in a review of the relevant literature point out that complex behavior may be acquired almost entirely through imitation. The provision of live or symbolic models serves to accelerate the learning process, and, in cases where time or error is costly, this technique becomes an efficient means of transmitting behavior patterns (Bandura and Walters, 1963; Bandura, Ross and Ross, 1963). Other research has shown that the level of the desired behavior exhibited by the observer can be as great as that exhibited by the model (McBrearty, Marston, and Kanfer, 1961). The implication of these findings for teacher training is that the provision of live or symbolic models displaying desired teacher behaviors may provide an effective alternative to purely descriptive techniques of training (McDonald and Allen, 1967).

The concept of imitation in psychological theory has a long history dating back to Lloyd Morgan (1896), Tarde (1903) and the doctrine of instinct. In more recent formulations it has been widely assumed that the occurrence of imitation, or observational learning, is contingent upon the administration of reinforcement either to the model or to the observer.

According to the theory proposed by Miller and Dollard (1941), the conditions necessary for learning include a motivated subject who is positively reinforced for matching the rewarded responses of a model.

Mowrer's (1960) proprioceptive feedback theory similarly highlights the role of reinforcement, focusing on the classical conditioning of positive and negative emotions to matching response correlated stimuli. According to Mowrer, imitative learning can occur either through pairing of the model's response with reinforcers dispensed to the observer, or by means of vicarious conditioning.

However, these reinforcement theories do not account for the learning of matching responses when the subject does not perform the model's responses during the process of acquisition and for which reinforcers are given neither to the model nor to the observer. The acquisition of imitative responses under the latter conditions can best be explained in terms of contiguity theory of observational learning (Bandura, 1965; Sheffield, 1961). According to this theory, it is assumed that when an observer witnesses a model exhibiting a sequence of responses, the subject acquires through the contiguous association of sensory events, symbolic or representational responses possessing cue properties capable of eliciting at a later time, overt responses matching those that have been previously observed. Accordingly, Bandura (1963, 1965) has argued that contiguity accounts for the acquisition of matching responses, whereas reinforcement influences the performance of imitatively learned responses.

It cannot be assumed that observational learning is contingent solely upon exposure of an observer to a complex sequence of stimulation. Bandura (1965) states that imitation is an active process in which modeling stimuli combine with other variables in shaping response patterns. Factors other than contiguity undoubtedly influencing imitative response acquisition would include: attention directing variables such as motivation, prior training in observation, and anticipation of reinforcement; rate, amount and complexity of stimuli presented to the observer; practice; observer characteristics and other variables.

McDonald and Allen (1967) have applied the research on observational learning to the learning of teaching behavior, and have obtained data pertaining to the following independent variables: (1) self-feedback and reinforcement; (2) variations in feedback and practice conditions; (3) film-mediated and written modes of model presentation. These studies have indicated that reinforcement and discrimination training administered by an experimenter were highly effective methods of producing behavior changes in teachers. Because of considerable information processing capabilities, human learners may require little in the way of feedback under many circumstances. However, if the responses to be learned are sufficiently complex, some type of feedback may be required. Moreover, exposure of an observer to a complex sequence of teaching behavior does not guarantee that Ss will attend to the most relevant stimuli, or accurately perceive the cues to which their attention is directed. Discrimination training, in which attempts have been made to focus Ss attention on relevant stimuli, has been shown to facilitate observational learning.

In the preceding experiments, it was observed that different kinds of training procedures appear to be differentially effective with trainees. While a great deal of individual variation has been observed within the written and film-mediated modeling conditions, differences between the two modes of model presentation have not been consistently significant. A promising line of research suggested by these results would appear to be a study of the interactions between the kinds of treatment used to produce behavior change and (1) the type of teaching skill to be learned, and (2) individual differences in the learner. A study has recently been undertaken to investigate interactions between various modeling procedures and types of dependent variables (McDonald and Allen, 1967). The purpose of the present study was to investigate the interaction of modeling procedures with individual differences in the learner.

Learning and Individual Differences

The relationship of tested abilities to learning rate has been of experimental interest for quite some time. Early investigators have examined the generality of learning ability to determine if a single learning ability accounts for performance in all learning situations. Over a wide variety of learning tasks, it has generally been found that measures of learning in such tasks exhibit low correlations both with other tasks and with intelligence measures. The usual conclusion has been that there is no general learning ability.

Husband (1939, 1941) was among the first to conclude that learning ability is not unitary but that there are a number of relatively independent learning abilities depending upon the type of task. The most substantial evidence on this point, however, comes from a series of studies by Woodrow (1938, 1939, 1940, 1946) in which a group of students were given a number of practice trials on a variety of learning tasks. A battery of special aptitude and intelligence tests was administered both before and after practice. The results obtained showed that there was no single general learning ability accounting for improvement on all tasks. Moreover, there was no significant relationship between scores representing gain with practice and intelligence. Additional research in this area (Simrall, 1947) has indicated that even when the types of material used in the learning tasks were highly similar to types of material used in the intelligence tests, gains during practice were still not significantly related to test scores. While methodological weakness and inappropriate statistical analysis (Rapier, 1962, Manning and Dubois, 1962) limit the usefulness of these early studies as a basis for conclusions, later interpretations (Humphreys, 1960; Porter, 1959) have generally supported the position that neither the amount gained nor the rate at which it is acquired show any consistent relationship to intelligence measures.

Related to the Woodrow trend is the work of Fleishman and his associates (summarized in Fleishman, 1965) on the relationship of ability factors to performance in the course of perceptual-motor skill learning. Investigators of learning have commonly used a terminal performance score as a criterion for learning. Such a score is believed to be an accurate representation of the learning that has taken place. However, Fleishman's findings have suggested that the learning of complex skills is a multidimensional process in which the contributions of individual differences associated with performance on a task change from early to later stages of learning. These findings serve to underscore the importance of experimental work on behavioral change which investigates the effects of task variables, particularly as they change over conditions of practice or instruction (Glaser, 1967).

The line of work generated by Woodrow is reflected today in the work of other differential psychologists who have related aptitudes to performance on various laboratory tasks (Allison, 1960; Stake, 1961; Duncanson, 1964). Generally, in these studies, a battery of reference tests is administered, the subjects complete various learning tasks, and regression or factor analytic techniques are used to relate learning to the reference tests. However, this line of investigation has been primarily concerned with task variables rather than instructional variables. While these studies have investigated the relationship of aptitudes to performance under conditions of practice, they have not generally compared ability-performance relationships under different methods of instruction. Thus, these results typically do not indicate any specific way in which _S_s could be treated or situations modified in order to maximize learning.

Direct pursuit of interactions between treatment and learner variables is infrequently represented in the literature. While interactions with instructional variables have most commonly been reported as incidental findings in experiments designed for other purposes, there are a few studies that have deliberately investigated relationships among learner characteristics and learning outcomes under different instructional conditions.

An investigation of individual differences and instructional film effects (Snow, Tiffin and Seibert 1965), using filmed and live lecture demonstrations found that a number of variables including ascendancy, responsibility, numerical aptitude, verbal aptitude, past experience with entertainment films, and past use of college library instructional films interacted significantly with instructional treatments.

Edgerton (1958), using Navy training courses, taught the same material by two different methods in an effort to modify the conventional rote instruction into a meaningful method. Correlations obtained indicated that the Thurstone memory and fluency factors interacted with the instructional conditions.

Grimes and Allinsmith (1961) compared primary reading achievement under two methods; a structured phonics program, and a less structured whole-word approach, with anxiety and compulsivity used as differential variables. It was anticipated that highly anxious or highly compulsive children would show more achievement under structured methods than similar children taught by the unstructured method. This expectation was supported. Moreover, anxiety and compulsivity, which were not correlated in their sample, interacted with each other as well as with instructional method.

Finally, Cronbach (1965), in a partial survey of the literature dealing with attitudes concerning confidence, willingness to risk failure, and motivation for self directed achievement, examined numerous indications from the work of Atkinson (1964), Wallach and Kogan (1964) and others that certain personality variables interact with instructional variables.

It seems clear that interactions may be discovered in a random exploration in which results under multiple instructional treatments are projected onto a mass of differential information. Cronbach (1965), however, argues for what he considers a more promising experimental strategy in which alternative treatments are designed to interact with specific differential variables. The design of the present study corresponds more closely to the latter strategy in that treatments were initially selected in terms of specific aptitude variables and then refined to maximize the effects of these variables.

Implications of Research on Observational Learning and Individual Differences

What are the implications of the previous discussion for study of the interaction of individual differences with modeling procedures in the acquisition of a teaching skill?

First of all, instructional methods differ. The literature reviewed here suggests that a person learns more easily from one method than another, that this best method differs from S to S and that such differences between treatments are related to learner characteristics.

Different methods of presentation may be employed in the use of modeling procedures. That is to say that different methods of presentation may be used to reach the same terminal objective. Among these are written and film-mediated models. For the purposes of this study, by "exposure to a film-mediated model" is meant that the learner has observed the actual filmed performance of another person who displayed the behaviors to be acquired. By "exposure to a written model" is meant that the learner has read a written transcription of the sound track from the film-mediated model. While both of these methods have been effective as training procedures, differences between the two treatments have not consistently been found (McDonald and Allen, 1967; Bandura and Mischel, 1965). However, in view of the task differences generated by the two different modeling treatments, it seems reasonable to expect that different abilities may also be involved.

A study by Wolfgang Boehm (cited by Cronbach, 1957) tends to lend support to this expectation. In this study, a sound film was shown to the experimental groups. Matched control groups read a verbatim text of the soundtrack. Differences in comprehension between the two groups were insignificant. However, a general mental test correlated only .30 with text learning, but predicted film learning with an average correlation of .77. This difference was consistent across all ages and would appear to support the hypothesis that different abilities might predict success on these two different methods of presentation.

In answer to the question of why purely audio-visual and purely written verbal treatments should be used when a combination of the two might be likely to produce a stronger training effect for all, or for any one or more sub-groups, it is suggested that such a separation is a useful research strategy which may offer a clearer understanding of the separate functions of the treatments and abilities involved. A mixed treatment might mask the functioning of aptitudes which may be interacting with treatment effects. Moreover, the two treatments utilized here have already been defined as meaningfully distinct by previous research. These treatments have both theoretically and practically distinguishable features. As Cronbach (1957) has argued, unless one treatment is clearly best for everyone, a situation which has not occurred for the treatments under consideration here, treatments should be differentiated in such a way as to maximize their interaction with aptitude variables. In this way, if interactions do exist, learning is maximized.

Definition of Relevant Abilities

While individual differences in performance on learning tasks can be measured as a function of numerous operationally defined variables in those tasks, and factor analytic studies can relate performance on a number of tasks to a variety of reference tests, ultimately, research on individual differences must be guided by theories of human learning and performance. As Melton (1967) has argued:

> What is necessary is that we frame our hypotheses about individual differences variables in terms of process constructs of contemporary theories of learning and performance (p. 239).

Accordingly, Melton has proposed an expanded version of a theoretical model initially described and tested by McGuire (1961) as a framework for investigating individual differences in learning. The model is shown in Figure 1.

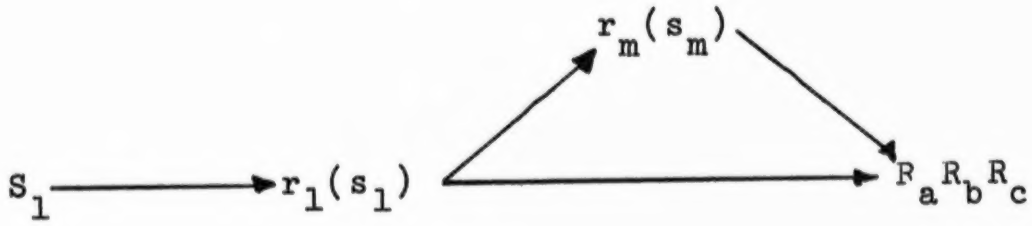

Figure 1. A Multi-Process Model of Learning

This model proposes a stimulus differentiation component, a response integration component, and a "hookup" between the encoded stimulus and the integrated response or a segment of it. The stimulus differentiation component ($S_1 \longrightarrow r_1$) is the subjects' coding response to the potential physical stimulus (S_1). It is the effective, or functional stimulus ($r_1(s_1)$) in S-R associations, and reflects such factors as learning and set as well as the physical stimulus. The response integration component ($R_aR_bR_c$) is the output response, which may be either a previously learned unit (R_a) or a new combination of such units, ($R_aR_bR_c$). The "hookup" is the connection ($r_1(s_1) \longrightarrow R_aR_bR_c$) between the functional stimulus and the required response. The component ($r_m(s_m)$) represents an alternative mediational route for the connection of the internal representation of the physical stimulus and the required response.

Differences and similarities in task and ability variables involved in the two modeling procedures previously described may be represented in terms of this paradigm. This representation is summarized in Table 1.

First, *S*s in the Film-Mediated Modeling condition view an actual portrayal of the teaching skill and of the

TABLE I

ORGANIZATION OF TASK AND ABILITY VARIABLES IN A MULTI-PROCESS MODEL OF LEARNING

$$\begin{tikzcd}
 & & r_m(s_m) \arrow[dr] & \\
S_1 \arrow[r] & r_1(s_1) \arrow[ur] \arrow[rr] & & R_a R_b R_c
\end{tikzcd}$$

	Stimulus Differentiation	Association Mediation	Response Integration
Written Model	Read script of sound track	Generate associative context	Retain representation
	Set own reading pace	Transform verbal to behavioral representation	Generate new associates
	Reread, pause as needed		Integrate in behavioral context
	Code as verbal representation		
Film-Mediated Model	View film, hear sound track	Generate associative context	Retain representations
	Keep pace with film	Transform behavioral to verbal representation	Generate new associates
	Review in memory		Integrate in behavioral context
Ability Variables	Flexibility of closure	Verbal Behavioral Transformation	Verbal memory
	Perceptual speed	Verbal Association	Audio-Visual memory
	Spatial scanning		Verbal fluency
	Short-term memory		
	Verbal comprehension		

pace of the lesson. This involves processing information from multiple channels simultaneously. Film-mediated models are extremely rich in perceptual detail in that there are many different cues to which to attend, including many extraneous to the relevant features of the model. These task characteristics would appear to require the ability to keep definite task-relevant dimensions in mind so as to make identification in spite of perceptual distraction. This ability may be similar to that commonly called flexibility of closure (Thurstone, 1944).

Moreover, _S_s in the Film-Mediated Modeling condition are expected to perceive and encode events as behavioral representation at the speed of presentation of the film. Consequently, they are able to review relevant material in memory only. The requirements of a predetermined pace would seem likely to involve speed in perceptual evaluation and in exploring a complicated spatial field, as well as short term memory facility.

In the Written Modeling condition, _S_s read a written transcription of the soundtrack from the film-mediated model. A written transcript of the model's behavior, however, presents only verbal components of these stimuli. Consequently, _S_s in the Written Modeling condition process information from a single channel in which they are able to establish their own pace and return to review relevant material as read. While Ss in the Written Modeling condition must also distinguish the significant features of the model, the total set of stimuli to select from is limited to verbal components. These task variables would be expected to require the ability to comprehend written verbal material.

Corresponding to the associational-mediational component of the model, it is hypothesized that Ss in both Film-Mediated and Written Modeling conditions must generate their own analogy to the model's performance. While Ss in the Film-Mediated Modeling condition are expected to abstract relevant verbal representation from behavioral representation, Ss in the Written Modeling condition are expected to generate relevant behavioral representation from solely verbal components. These task variables would appear to require facility in both verbal association and in verbal-behavioral transformation. Although these abilities would appear to be involved in both treatments, they are presumed to be more decisively involved in the Written Modeling condition. Because of the abstraction of the script, or compression of stimuli into solely verbal components, a greater degree of verbal processing would appear necessary for those in the Written Modeling condition to generate associative context and behavioral representation. S̲s in the Film-Mediated Modeling condition have only to recall much of what S̲s in the Written Modeling condition must produce.

Finally, corresponding to the response integration component of the model, it is expected that S̲s in both conditions need to retain representations of their respective models, generate new examples of the skill being modeled in the teaching situation, and integrate these examples into a behavioral context. These task variables would be expected to require both verbal fluency, and the ability to remember major ideas as well as details from audio-visual presentations in the case of S̲s in the Film-Mediated Modeling condition, and verbal presentations in the case of S̲s in the Written Modeling condition.

Ability Measures

The selection of ability measures for use in this study was made from the Kit of Reference Tests for Cognitive Factors (French, Ekstrom and Price, 1963) and from a series of film and audio tests developed by Seibert and Snow (1965) and Seibert, Reid and Snow (1967). The abilities assessed are believed to be those which distinguish most clearly between the two modeling conditions and are consistent with the analysis of the Film-Mediated and Written-Modeling conditions previously discussed.

The Kit of Reference Tests for Cognitive Factors was developed from a project organized to select tests to represent each of the better established factors in the cognitive behavioral domain. It consists of a group of tests representing each of the more frequently obtained factors in the cognitive ability area, rather than a standardized battery of tests. The purpose of the kit is to provide research workers with a set of tests for defining each of these factors and for facilitating interpretation and comparison of one factor study with another.

The manual does not provide the reliability, norming, validity or other information usually included in a test manual. Such information has not been included because these tests are suggested for the single purpose of factorial research. Consequently, there is no comprehensive information on how these tests intercorrelate. Where there is information on some of the tests, it has been gathered on samples dissimilar to the one used in this study. However, all of the tests have two separately timed parallel parts to permit the estimation of reliability, and a correlation matrix has been computed to provide additional necessary information for subsequent discussion.

The film and audio tests were developed in an effort to examine alternatives to conventional printed paper tests in psychometric research. It is argued by Seibert and Snow (1965) that since human beings behave in contexts which are not static, not primarily verbal, and not characterized by the presence of print, it is conceivable that some of this behavior involves abilities or predispositions which are not amenable to adequate sampling with printed paper tests.

The purpose of their investigation was to begin the exploration of individual differences in performance on tasks characterized by moving, sequential or behavioral content. Since those characteristics were involved in the present study, it was thought that these tests would provide useful information. Tests chosen from the Kit of Reference Factors for use in this study have also appeared prominently in the factor interpretations of the earlier film test study.

A brief description of the ability tests and the factors they represent follows:

Hidden Figures (Cf-1, Flexibility of Closure). A test of the ability to keep one or more definite configurations in mind so as to make identifications in spite of perceptual distraction. The visual and auditory modalities of the closure factor have been shown to be highly correlated. (White, 1954)

Identical Pictures (P-3, Perceptual Speed). A test of speed in finding figures, making comparisons and carrying out other tasks involving rapid checking and perceptual evaluation.

Maze Tracing (Ss-1, Spatial Scanning). Related to perceptual speed is spatial scanning ability, which is described as speed in visually exploring a wide or complicated spatial field. Tests of perceptual speed and spatial scanning tended to appear together on a film test factor (Seibert and Snow, 1965) hypothesized to involve rapid serial processing of spatial images, and suggesting the dynamic information processing nature of this ability.

Advanced Vocabulary (V-4, Verbal Comprehension). A test of the ability to understand the English language. Individual differences are most clearly seen in the size of comprehension vocabularies, but also exist with respect to tests demanding knowledge and understanding of grammatical patterns, sentences, phrases and other aspects of the English language.

Word Arrangement (Fe-3, Expressional Fluency). A test of ability to think rapidly of appropriate wording for ideas. The emphasis in this test is on facility in producing connected discourse that will fit restrictions imposed in terms of given words.

Film Memory. A test of the ability to identify verbal descriptions from remembered behavioral content. It consists of a motion picture presentation, followed by printed questions concerning the action portrayed.

Memory for Ideas. A test of ability to abstract major ideas from remembered audio taped verbal presentation.

Sentence Reproduction. A test of the ability to reproduce verbal material in detail from remembered audio taped verbal presentation.

GRE Verbal Aptitude scores were also used in this study. This score represents verbal reasoning and reading comprehension.

The Dependent Variable

Educators hold that one of the major objectives of instruction in the schools is the development of skills or strategies which will enable students to become lifelong autonomous learners. While the content of any field may undergo rapid change, the ability to analyze critically written materials within that content area is an objective of any field of study (Bloom, 1956). One way of developing such ability in students is to train teachers to ask the kinds of questions that require students to engage in the analysis of their reading material. With this objective in mind, the dependent variable developed for use in this study is termed Analytic Questioning.

The basic ideas underlying the development of Analytic Questioning were derived from Taxonomy of Educational

Objectives (Bloom, 1956) which presents a plan for classifying educational objectives. This taxonomy was developed from a project organized to achieve a more widely accepted set of behavioral objectives that could be more profitably used for communication and for guiding research in connection with curricula, teaching and examining in education.

Bloom and his associates claim that any educational objective can be classified within their taxonomy, and imply that any question can also be classified. One of the ways in which each category was defined was by using examples of questions that required students to engage in specified kinds of behavior (Sanders, 1966). Accordingly, if the objectives of the taxonomy are considered to be worthwhile educational objectives, training teachers to formulate questions requiring students to engage in the behavior specified as an objective would consequently be considered a worthwhile training objective for prospective teachers. Thus, analysis of elements, a subset of the general objective of Analysis, was selected as an appropriate source for training teachers in questioning behavior.

The Taxonomy of Educational Objectives defines Analysis in the following manner:

> The breakdown of a communication into its constituent elements or parts such that the relative hierarchy of ideas is made clear and/or the relations between the ideas expressed are made explicit. Such analyses are intended to clarify the communication, to indicate how the communication is organized, and the way in which it manages to convey its effects, as well as its basis and arrangement. (p. 205)

Although Analysis may be conducted simply as an exercise in identifying structure and organization in a communication, it is probably more educationally useful as an aid to fuller comprehension or as a prerequisite to higher level skills in the taxonomy, such as Synthesis or Evaluation.

The Analysis of Elements is specifically concerned with the breakdown of a communication into its constituent parts, i.e. to identify or classify the elements of a communication. Any communication may be conceived of as composed of a number of elements, some of which are explicitly stated in the communication and can be recognized and classified relatively easily. However, there are other elements in a communication which are not as clearly labeled. These elements can be inferred only from an analysis of a series of statements within the communication. Until the reader can detect them, he may have difficulty in fully comprehending or evaluating the communication.

A detailed discussion of the dependent variable appears in the Raters Manual (Appendix A). Thus comments here will be brief. The categories of Analytic Questioning are the following:

1. Identification of Hypotheses
2. Semantic Definition
3. Identification of Unstated Assumptions
4. Distinction of Factual from Non-Factual Statements
5. Identification of Conclusions

The labels in each case generally reflect the teacher's goal when using a given category of questions.

Statement of Hypotheses

Based upon the previously reviewed research and theory, the basic hypotheses derived and tested were:

1. Both Film-Mediated and Written Modeling conditions will produce significantly greater changes in the response strength of desired behaviors than will the Control condition
2. For subjects receiving the Film-Mediated Modeling condition, criterion scores should show stronger relation to perceptual abilities

than for subjects receiving the Written Modeling condition.

3. For subjects receiving the Written Modeling condition, criterion scores should show stronger relation to verbal abilities than for subjects receiving the Film-Mediated Modeling condition.

These hypotheses imply that there are nonparallel regression slopes, and consequently, that one treatment will not be superior throughout the distributions of the perceptual and verbal ability variables. For the purpose of this study the term "perceptual abilities" has been used to include both tests of figural cognition from the French Kit and the audio visual memory tests. While the audio-visual tests are experimental in nature, and it is not yet clear precisely how they should be classified, they have been tentatively grouped with the tests of figural cognition, mainly because of their mode of presentation. The term "verbal abilities" has been used to include written tests of verbal cognition.

Although perceptual and verbal abilities are referred to here in a seemingly unitary sense, it should be emphasized that tests representing these abilities are presumed to be independent factor tests. While it may be anticipated that both perceptual and verbal abilities would display a tendency to correlate more highly with one another than with other more dissimilar measures, identical ability-performance relationships have not been anticipated for all tests of a given class. The relationship of any particular test labeled "perceptual" or "verbal" to any particular instructional outcome may be expected to vary as a function of its relevance to both task and process variables.

CHAPTER II

EXPERIMENTAL DESIGN

Subjects

Intern subjects were drawn from the Stanford Teacher Education Program. They were initially categorized by the subject matter they were teaching, and subsequently, randomly assigned to one of three treatment conditions. All of the subject matter areas of the Stanford Teacher Education Program were represented with the exceptions of foreign language and physical education majors. In both of these cases it was felt that the prescribed methodology was inappropriate for the systematic use of the dependent variable, Analytic Questioning. Moreover, use of the audio tapes of foreign language majors would have created undue transcription and measurement problems.

Relevant characteristics of the sample studied appear in Table 2 which provides the distribution of subjects by sex and subject matter.

The *S*s ranged in age from 21 to 40 years, although the variability was relatively small with most of

TABLE 2

NUMBER OF SAMPLE SUBJECTS BY SEX AND SUBJECT MATTER

N = 121

Treatment Group	N	Sex		Subject Matter Major					
		M	F	English	Social Science	Science	Mathematics	Art	Music
Film-Mediated Modeling	41	8	33	13	17	5	3	2	2
Written Modeling	40	9	31	11	18	4	3	2	3
Control	40	12	28	11	16	5	3	2	1

the ages falling near the mean of 23.0. The mean undergraduate Grade Point Average of this group was 3.03.

Interns taught each of their lessons to a microclass of four students. These students were randonly assigned to teams of four which were subsequently randomly assigned to Ss within treatment groups. The microstudents were drawn from the Palo Alto school system and were paid for their services. A total of 120 students were hired. All students were either tenth or eleventh graders with a grade point average of 3.0 or better. The majority of these students were from middle class backgrounds.

Ability Measurement

Ss were tested prior to their participation in the experimental procedures. Tests were administered in a single two and one-half hour session on two separate occasions. Testing time included instructions, practice exercises and a fifteen minute rest interval.

In the first testing session, it was impossible for all Ss to be tested together in the same room because of the size of the intern group and the nature of the audio-visual tests. Consequently, the one large group was divided into two smaller groups which were tested simultaneously, in separate rooms. Moreover, the amount of equipment involved in the administration of the audio-visual tests, and the limitations imposed by physical facilities did not permit the duplication of audio-visual facilities in both rooms. Therefore, each group was administered the tests in two separate sets--a set of audio-visual tests and a set of paper and pencil tests from the Kit of Reference Tests for Cognitive Factors. Upon completing the first set of tests, subjects changed rooms and completed the second set. Within each of these two sets the order of test administration was randomly assigned.

A second testing session was provided for those Ss unable to attend the first session. This group was small enough to permit all Ss to be tested together. Thus, in this group it was possible to administer the two sets of tests in a random mixed order. A summary of the testing procedures appears in Table 3.

Tests were hand scored by three trained scorers working under the direction of the experimenter. Objective test scoring keys were used on all tests with the exceptions of Word Arrangement, Memory for Ideas and

TABLE 3

ABILITY MEASURES

Test	Time	Number of Parts	Presentation Order Session One 1 N=45	Presentation Order Session One 2 N=42	Presentation Order Session Two 1 N=34
Kit of Reference Tests for Cognitive Factors					
Hidden Figures (Cf-1)	20 min	2	1	4	7
Identical Pictures (P-3)	3 min.	2	2	5	8
Maze Tracing (Ss-1)	6 min.	2	3	6	3
Word Arrangement (Fe-3)	8 min.	2	4	7	2
Advanced Vocabulary (V-4)	8 min.	2	5	8	4
	45 min.				
Audio-Visual Tests					
Film Memory	7 min.	1	6	1	1
Memory for Ideas	16 min.	2	7	2	5
Sentence Reproduction	34 min.	2	8	3	6
	57 min.				

Sentence Reproduction. Scoring directions for these tests were sufficiently unambiguous as to cause little scoring uncertainty. When such uncertainty did arise, it was resolved by the experimenter. Scoring was checked for accuracy. Both part scores and total scores were recorded for each test. GRE-Verbal Aptitude scores were available from Stanford Teacher Education Program records.

Treatment Procedures

A total of 121 Ss were used in this study. All Ss had been administered the selected ability measures prior to the presentation of the learning task. Each S was randomly assigned to one of three treatment conditions: a Film-Mediated Modeling condition in which subjects were exposed to filmed portrayal of the behavior to be learned, Analytic Questioning; a Written Modeling condition in which Ss read a verbatim text of the sound track from the film-mediated model; and a Control group which received no model, but went through all other steps common to the previously mentioned two groups.

The treatment procedure may be broken down into nine steps. In seven of these steps, all groups received identical treatment. In the remaining two, each group was exposed to the appropriate type of modeling procedure. Thus, treatments were held constant in all ways except for the mode of model presentation.

The treatment procedure was broken down into the following steps:

1. Set Induction--Ss were presented with brief written instructions describing the nature of the learning task (Appendix B).
2. Teaching Session One, (T_I)--A preevaluation of each S was made prior to the presentation of the model as each intern presented a ten minute lesson to a microclass of four students. Criterion scores from this lesson provided a baseline frequency of the desired behavior.
3. Model Lesson One--Depending on their assignment to an experimental condition, Ss were exposed to a written or film-mediated version of a model exhibiting Analytic Questioning behavior. The Control group was given a set of written materials extraneous to the learning task in order to fill the equivalent time block. (Appendix C).

4. Rehearsal One--Ss were given five minutes to incorporate the modeled behavior into their planned lesson.
5. Teaching Session Two, (T_2)--Ss taught a second ten-minute lesson.
6. Model Lesson Two--Ss were exposed to the same model presentation as used in step 3.
7. Rehearsal Two--Ss were given five minutes to incorporate the modeled behavior into their planned lesson.
8. Teaching Session Three, (T_3)--Ss taught a final ten-minute lesson.
9. Testing Session--Ss were given two written tests covering material presented in the treatment procedures (Appendix D).

A summary of the procedures appears in Table 4. All Ss thus received written instructions followed by two cycles comprised of models, rehearsal, and teaching. Treatments were terminated with the completion of the written tests. Ss taught a different group of students in each lesson. This permitted them to revise the same basic subject matter while attending to the improvement of Analytic Questioning behavior.

TABLE 4

TREATMENT PROCEDURES

Steps	Group			Time
	Film-Mediated Modeling	Written Modeling	Control	
1. Set Induction	×	×	×	5 min.
2. Teach 1	×	×	×	10 min.
3. Model 1	film mediated	written	extraneous material	10 min.
4. Rehearsal 1	×	×	×	5 min.
5. Teach 2	×	×	×	10 min.
6. Model 2	film mediated	written	extraneous material	10 min.
7. Rehearsal 2	×	×	×	5 min.
8. Teach 3	×	×	×	10 min.
9. Test Administration	×	×	×	5 min.

Explanation of Symbols: (×) indicates that all Ss received this step of the treatment in an identical manner. Written descriptions are provided for the two steps in which treatments varied among the three groups.

Procedures for Model Preparation

An experienced teacher was selected to portray Analytic Questioning in the film-mediated model. The model was thoroughly familiarized with both the skill to be modeled and the desired quality level through written materials, discussion, and illustration of representative examples from each category of Analytic Questioning. A ten-minute lesson was planned by the model and experimenter together to provide at least two representative examples of each category of Analytic Questioning. Micro-students participating in the videotaping of the model were provided training along with the teacher on the categories of questions to be asked, and appropriate responses to each of these.

Several trials were provided for taping the model lesson. During each trial, the experimenter recorded the number and quality level of the Analytic Questions used, and noted suggestions for improvement. The model and experimenter would subsequently review the lesson previously taught and make revisions where necessary. From this pool the best of the tapes was selected.

Upon completion of the film-mediated model, a brief commentary was superimposed on the soundtrack to aid the discrimination of important behaviors in the lesson. A verbatim text of the soundtrack was then typed from the film-mediated model to provide the written model (Appendix C). The commentary superimposed on the soundtrack of the film-mediated model appeared on the written model in exactly the same form and place in the lesson.

Lesson Material

Because the extent to which Analytic Questioning can be systematically used is partially a function of the opportunities provided for such questioning by the lesson material at hand, lesson material was preselected for Ss in this experiment. With the help of both faculty members and intern supervisors, material was selected to meet the following criteria:

1. The lesson material had to provide a rich source for the systematic use of Analytic Questioning.
2. The lesson material had to be adaptable to the ten-minute teaching interval established.
3. The content of the lesson material could not presuppose a substantial amount of prior information on the part of the microstudents.

A total set of thirteen written communications was finally selected to serve as lesson material. The number of lessons selected in each subject matter area represented a ratio of approximately one lesson for every eight interns in that subject matter area. This was done to avoid overexposure of microstudents to any given lesson, and also to demonstrate the utility of Analytic Questioning, as a questioning strategy, over a variety of materials. The topics represented in this selection included student activism, the hippie culture, the use of drugs, the definition of patriotism, the cultural value of pop music, and others. Sources for this material included newspaper and magazine articles in addition to material especially written for the purposes of this study.

Lessons were randomly assigned to Ss within subject matter areas and treatments, and were distributed to them one week prior to their participation in the experiment. Interns were instructed to come prepared to teach a ten-minute lesson discussing this written material with the microstudents. In addition, they were told that the microstudents would also have copies of this material which they would be prepared to discuss at that time.

Procedures for Training Microstudents

Training was provided for microstudents for the following reasons: (1) the complexity of the dependent variable, (2) the ceiling effect on its frequency of occurrence imposed by time and availability of appropriate student responses.

Treatments were designed to produce increases in Analytic Questioning behavior. However, both the questioning strategy and the lesson material selected were complex. While the ability level of the microstudents was specified with this in mind, the questioning strategy is tied to the analysis of the written material at hand. Unless student responses were highly available, much of the ten-minute lesson period could have been spent in searching the written material for appropriate answers, limiting the frequency with which such questions could be asked by the teacher. This would serve to mask the functioning of treatment effects. Accordingly, optimal conditions for the demonstration of treatment effects would necessarily include high response availability on the part of the students.

Training of the microstudents was accomplished in the following manner. One week prior to the experiment, all microstudents attended an orientation meeting in which copies of each set of lesson materials to be used for analysis were distributed along with a description of the categories of questions which they could expect to be asked with respect to that material. Examples of appropriate questions and answers for each lesson corresponding to each of the categories of Analytic Questioning were provided. Students were instructed to be well prepared on this material as their participation in microteaching would be contingent upon their successful completion of a written test on the material to be administered prior to each day of microteaching in which they were to participate.

A random sample of four lessons was selected as a source for this test prior to each day of microteaching. Students were instructed to list at least one example of material corresponding to each of the categories of Analytic Questioning for each lesson. These tests were checked by the experimenter together with assistants. No microstudent failed to meet these minimal criteria.

Criterion Measures

Consideration was given to several aspects of Analytic Questioning skill. As a result both classroom performance and written criterion measures were developed for use in assessing treatment effects and ability-performance relationships.

Classroom Performance Measures

Several criterion measures were obtained from transcripts of the classroom interaction of intern and microstudents over three teaching sessions.

First, treatments were designed to produce increases in Analytic Questioning as a general questioning strategy. While different levels of significance might be examined in relation to each subcategory of Analytic Questioning, differences of this nature were not emphasized in the model presentation. Therefore, the total number of analytic questions was selected as one appropriate index for measuring increases in Analytic Questioning.

In addition to the total frequency, the variety of categories of Analytic Questioning used was also of considerable interest. Theoretically, the use of any category of Analytic Questioning by Ss represents an available class of responses in the behavioral repertoire of that S as well as a single occurrence of a behavior of interest. Accordingly, for the purpose of this study, a total frequency score representing the use of all categories would demonstrate more desirable training effects than would the same total frequency score representing the use of fewer categories of Analytic Questioning.

Finally, while attention so far has been focused exclusively on frequency measures, it was recognized that the quality of the questions might also be considered a potentially important dimension of the dependent variable. Some analysis of quality had already been done in specifying those kinds of statements fitting into the category system. These categories were meant to include the best examples of the behavior being learned. While weaker or more ambiguous examples, which would not clearly meet the criteria imposed by the category definition, would undoubtedly represent levels differing in quality, a considerable degree of precision in classification was believed necessary so that the extent of imitation could be assessed. However, in developing the rating manual additional differences of such a character were considered.

Quality is commonly defined as an approximation to an ideal or standard. Accordingly, for the purposes of this study, "quality" was used to distinguish between near versus more remote approximations to the behavior exhibited by the model. It had been observed in a previous study (Koran, 1967) using a similar questioning strategy, that one dimension along which questions in any given category tended to vary was that of information content. Thus, information content was selected as the dimension along which approximation to the behavior of the model would be assessed. In all cases, the questioning behavior exhibited by the model in this study required the student to supply the maximum amount of information that could be elicited by that particular type of question. The closest approximations to the model's behavior would also do this. In more remote approximations, the teacher would supply varying amounts of information which the model had elicited from the students. Accordingly, questions meeting the criterion established for high quality were designed to elicit from the students all information relevant to answering them. Questions requiring students to supply only part of the information relevant to answering them, or requiring only that students agree, disagree or select from among given alternatives would not meet the criteria imposed by this specification of quality.

To illustrate: the information content of a semantic definition has been defined as a statement of the methods and standards used for defining a word. The question "How does the author define social class"? requires students to supply the key elements of the definition as well as the method of measurement, and would accordingly be classified as a question of high quality. However, the questions "How does the author define social class with respect to income level"? and "Does the author define social class in terms of occupation, education or income"? provide part or all of the specified information content, and thus would not meet the criteria established for high quality. A complete discussion of quality, as used here, appears in the Rater Manual (Appendix A).

It should be noted that quality, as defined here, is not intended to represent an evaluation of which kinds of questions are "best." Any question could possibly be made "better" or "worse" by changes which do not involve approximation to the behavior of the model along the dimension of information content. Attention is focused on the quality dimension used here only to the extent that it can be used to assess the extent of imitation.

Written Measures

While ultimately, decisions in teacher training must be guided by the effectiveness of training procedures in the transmission or modification of actual classroom teaching behavior, written measures were introduced in an effort to gather additional information useful in assessing ability-performance relationships in observational learning. These measures consisted of two recognition type tests (Appendix D). These written tests were designed in the following manner:

1. A true-false test in which subjects were asked to identify the major categories of Analytic Questioning. (2 minutes)
2. A multiple choice test in which subjects were asked to match a number of questions according to membership in a particular subcategory of Analytic Questioning. (3 minutes)

A common observation has been that differences exist between measures of knowledge or comprehension, and measures of actual performance in a given situation (Cronbach, 1963). In terms of the model proposed for investigating individual differences in learning that was previously discussed, ability-performance relationships may be expected to vary as a function of the nature of the task. While certain abilities, such as those associated with verbal production, may be more decisively involved in classroom performance measures, it is conceivable that different abilities, such as those related to perception and memory, may be more likely to be involved in recognition measures of the type used here.

Methods of Gathering Data

During the study each of the intern's lessons was recorded on stenorette tape. Technicians collected the tapes at the end of each lesson and labeled them with each Ss name, treatment group and number of teaching session. Each tape was monitored in order to assure that the volume and length were adequate. Typists then prepared a written transcript of each lesson. Each stenorette used for transcribing was equipped with a timing device which permitted the accurate recording of the ten minute completion time.

Written tests were collected following the third teaching session. Each test was labeled with Ss name and treatment group. Objective scoring keys were used for both tests.

Procedures for Training Raters

Prior to the analysis of the experimental tapes, a preliminary manual was developed from the written description of the dependent variable and analysis of the model lesson. A team of four raters was given intensive training on the definition of each category of Analytic Questioning and the use of the preliminary rating manual.

Raters were trained using three complete tapes (nine teaching sessions) representing the teaching sessions of one S from each of the three treatment groups. In addition to these, the written model along with discarded versions of the film-mediated model were also used for training purposes. The experimenter and team of raters systematically rated each of the training scripts and tapes. On the basis of experience with these, the preliminary manual was revised, and a final Rater Manual was developed (Appendix A). Approximately 40 hours were spent in training.

Once an acceptable level of agreement was reached, the raters independently rated the experimental scripts. Reliability was maintained throughout the analysis by scheduling occasional meetings where raters would review relevant decision rules and training scripts. This was done to insure that systematic rating biases would not develop. Neither ratings done during training nor in subsequent meetings were used in the statistical analysis of results.

Rating Procedures

Scripts were typed from audio tapes of each teaching session and were coded according to _S_, treatment and number of teaching session. This was done to insure that the raters had no knowledge of the _S_s name, treatment condition, or phase in the treatment condition. In each script, all questions were subsequently marked and numbered. Scripts were than subdivided into four groups and distributed to raters. When scripts were completed by one judge they were exchanged with the three other judges until each judge had rated every script. Each rater used a standard form (Appendix E) for recording the occurrence of _Analytic Questioning_ behavior. Rater scores were subsequently transferred to coding sheets and data cards for analysis.

Rater Reliability

The reliability of scores was established for judges 1, 2, 3, and 4 over all rated categories. The

Analysis of Variance repeated measures model described by Winer (1962) was used for this purpose. This analysis provides two reliability coefficients: (1) an estimate of the reliability of the mean of four ratings, which represents the expected correlation between mean ratings for the same people with other random samples of judges, and (2) an estimate of the reliability of a single measurement, which is approximately equal to the average intercorrelation between ratings given by pairs of judges.

The reliability of both the mean scores and of a single measurement for each rated category for each teaching session appears in Table 5. These coefficients are extremely high, suggesting that the criterion measures are sufficiently reliable for testing both treatment effects and ability-performance relationships.

The reliability coefficients reported are somewhat higher than expected on the basis of the general literature on rating. The extensive pretraining of raters, the specificity of the behavior rated, and the derivation of the ratings from static transcripts rather than from ongoing behavioral sequences are believed to have contributed to the high reliability coefficients.

TABLE 5

RATER RELIABILITY

Category	Teaching Session 1		Teaching Session 2		Teaching Session 3	
	a	b	a	b	a	b
Total Analytic	.95	.88	.99	.96	.99	.97
Hypotheses	.95	.87	.96	.88	.96	.88
Definitions	.94	.85	.97	.90	.97	.94
Assumptions	.98	.93	.99	.97	.99	.97
Facts	.97	.90	.97	.94	.97	.93
Conclusions	.90	.75	.95	.87	.96	.95
Total Categories	.96	.90	.98	.94	.98	.95
High Quality Level	.92	.81	.98	.94	.98	.95
Total Non Analytic	.98	.95	.99	.97	.99	.96

a - Figures in this column represent coefficients of the reliability of mean scores.

b - Figures in this column represent coefficients of the reliability of a single measurement.

CHAPTER III

RESULTS

The primary objectives of this study were:

1. To assess the relative effects of different modes of model presentation.
2. To explore the effects of individual differences on observational learning.

This chapter will describe the statistical tests of the hypotheses and the results achieved. The presentation of results will treat first, the instructional treatment main effects; second, the ability measures; and finally, the aptitude × treatment interactions.

A complete list of all independent and dependent measures to be analyzed appears in Table 6. The distributions of scores for the dependent measures permitted evaluation by parametric techniques. Most analyses were computed using UCLA Bio-Medical Programs (Dixon, 1964).

TABLE 6

INDEPENDENT AND DEPENDENT MEASURES

Independent Measures		Dependent Measures
Hidden Figures	- Part I	Analytic Questions, T_1
Hidden Figures	- Part II	Categories of Analytic Questions, T_1
Hidden Figures	- Total	High Quality Analytic Questions, T_1
Identical Pictures	- Part I	Nonanalytic Questions, T_1
Identical Pictures	- Part II	Analytic Questions, T_2
Identical Pictures	- Total	Categories of Analytic Questions, T_2
Maze Tracing	- Part I	High Quality Analytic Questions, T_2
Maze Tracing	- Part II	Nonanalytic Questions, T_2
Maze Tracing	- Total	Analytic Questions, T_3
Word Arrangement	- Part I	Categories of Analytic Questions, T_3
Word Arrangement	- Part II	High Quality Analytic Questions, T_3
Word Arrangement	- Total	Nonanalytic Questions, T_3
Advanced Vocabulary	- Part I	True-False Test
Advanced Vocabulary	- Part II	Matching Test
Advanced Vocabulary	- Total	
Verbal GRE		
Film Memory		
Memory for Ideas	- Part I	
Memory for Ideas	- Part II	
Memory for Ideas	- Total	
Sentence Reproduction	- Part I	
Sentence Reproduction	- Part II	
Sentence Reproduction	- Total	

Instructional Treatment Main Effects

Classroom Performance Measures

The means of classroom performance measures were derived for each S by averaging the scores given on each category by each of the four judges. All analyses were computed using these mean scores.

The results for the four classroom performance measures previously described were analyzed separately for each of the three teaching sessions, although in some cases, the relationship among these measures was sufficiently high to suggest that they do not represent psychologically different variables. This was done in view of differences in ability-performance relationships observed and because of the unavailability of computer programs for multivariate analysis of variance techniques. Intercorrelations among dependent measures are reported both for the total sample (Table 7) and for each experimental group separately (Appendix F).

The initial test used to determine if there were significant instructional treatment main effects on the criterion variables was a 3 × 3 repeated measures analysis of variance. Since conformity of the data to the homogeneity

TABLE 7

INTERCORRELATIONS AMONG DEPENDENT VARIABLES FOR TOTAL SAMPLE

		2	3	4	5	6	7	8	9	10	11	12	13	14
1	Analytic Questions, T_1	77	83	15	29	23	29	-02	29	22	25	09	08	-07
2	Categories, T_1		68	19	14	15	14	06	14	10	10	15	00	-07
3	High Quality, T_1			18	20	14	22	-04	23	14	25	11	-05	-16
4	Nonanalytic, T_1				03	-07	01	34	09	-06	06	44	06	-16
5	Analytic Questions, T_2					78	95	-30	74	70	73	-28	49	42
6	Categories, T_2						74	-36	64	73	62	-29	40	43
7	High Quality, T_2							-31	68	67	71	-29	45	42
8	Nonanalytic, T_2								-30	-31	033	65	-21	-21
9	Analytic Questions, T_3									83	94	-27	48	40
10	Categories, T_3										81	-27	46	47
11	High Quality, T_3											-31	48	42
12	Nonanalytic, T_3												-24	-29
13	True-False Test													56
14	Matching Test													

Decimals omitted

assumptions underlying the use of this model appeared questionable (Appendix G), separate one and two-way analyses of variance were also computed for each measure of the dependent variable. Since the results were the same for both methods of analysis, the repeated measures analysis of variance was selected as the more parsimonious way of reporting these data. However, the results of the separate one and two-way analyses of variance are reported in Appendix H.

In accordance with Winer (1962), when the interaction between the two factors in the repeated measures analysis of variance was significant, tests on simple main effects were computed in addition to direct tests on main effects. In such cases, both direct tests on main effects and tests on simple main effects are reported separately. In all cases, the Newman-Keuls procedure (Winer, 1962) was used in comparisons of pairs of treatments following a significant overall F ratio (Appendix I).

Table 8 presents the means and standard deviations of the classroom performance measures for each of the three experimental groups.

Analytic Questions. The results for the repeated measures analysis of variance of the frequency of Analytic

TABLE 8

MEANS AND STANDARD DEVIATIONS OF DEPENDENT VARIABLES

	Treatment Group					
Performance Measure	Film-Mediated Modeling		Written Modeling		Control	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Analytic Questions, T_1	3.61	3.37	3.62	3.30	3.72	3.10
Categories of Analytic Questions, T_1	1.43	1.12	1.75	1.01	1.76	1.11
High Quality Analytic Questions, T_1	1.88	2.02	1.75	1.89	2.18	2.24
Nonanalytic Questions, T_1	23.26	9.41	24.39	9.33	25.24	10.80
Analytic Questions, T_2	13.40	6.41	8.16	5.59	3.31	2.50
Categories of Analytic Questions, T_2	3.73	1.19	2.89	1.39	1.59	1.05
High Quality Analytic Questions, T_2	9.90	5.20	5.17	3.84	1.92	1.70
Nonanalytic Question, T_2	16.02	9.36	19.12	11.49	25.40	10.57
Analytic Questions, T_3	13.58	6.33	10.09	7.11	2.93	3.25
Categories of Analytic Questions, T_3	3.85	1.17	2.98	1.37	1.33	.97
High Quality Analytic Questions, T_3	10.15	5.52	6.72	4.42	1.68	2.24
Nonanalytic Questions, T_3	15.50	8.16	17.23	9.15	25.96	12.72
Matching Test	11.82	2.36	10.67	3.09	7.97	2.88
True-False Test	10.70	2.02	9.77	2.35	7.00	1.90

Questions are presented in Table 9. In view of the significant interaction between treatment groups and teaching sessions, ($F = 29.41$, $p < .01$) tests on simple main effects were computed (Table 10). These tests disclosed highly significant treatment effects both for T_2 ($F = 46.27$, $p < .01$), and for T_3 ($F = 50.55$; $p < .01$), while no differences between groups were found for T_1 ($F = .01$). Comparisons between pairs of treatment conditions using the Newman-Keuls procedure showed that for both T_2 and T_3, the Written and Film-Mediated Modeling groups generated significantly more Analytic Questions ($p < .01$) than did the Control group. Moreover, Ss in the Film-Mediated Modeling condition produced significantly more Analytic Questions than did Ss in the Written Modeling condition on both T_2 and T_3 ($p < .01$).

An alternative view of the relative efficacy of the different instructional treatments in augmenting the frequency of Analytic Questions is furnished by within-group analyses of the increase from base rate to subsequent teaching sessions. The increase was found to be significant for both the Film-Mediated ($F = 30.13$; $p < .01$) and Written ($F = 9.74$; $p < .01$) Modeling groups. The Control group did not display increments in the frequency of Analytic Questions ($F = .14$). These modeling effects are illustrated in Figure 2.

TABLE 9

ANALYSIS OF VARIANCE OF ANALYTIC QUESTIONS

Source of Variation	df	MS	F	p
Between Subjects	119			
Treatment Groups	2	1422.66	32.10	.01
Subjects Within Groups	117	44.32		
Within Subjects	240			
Teaching Sessions	2	992.67	75.31	.01
Treatments × Sessions	4	387.64	29.41	.01
Sessions × Subjects Within Groups	234	13.18		

TABLE 10

SUMMARY OF ANALYSIS OF VARIANCE OF ANALYTIC QUESTIONS SIMPLE MAIN EFFECTS

Source of Variation	df	MS	F	p
Beteen Groups				
Treatments at Teaching Session 1	2	.16	.01	NS
Treatments at Teaching Session 2	2	1030.25	46.27	.01
Treatments at Teaching Session 3	2	1191.01	50.55	.01
Error Between Groups	351	23.56		
Within Groups				
Sessions of Film-Mediated Modeling	2	1335.51	30.13	.01
Sessions of Written Modeling	2	442.00	9.74	.01
Sessions of Control	2	6.30	.14	NS
Error Within Groups	234	13.18		

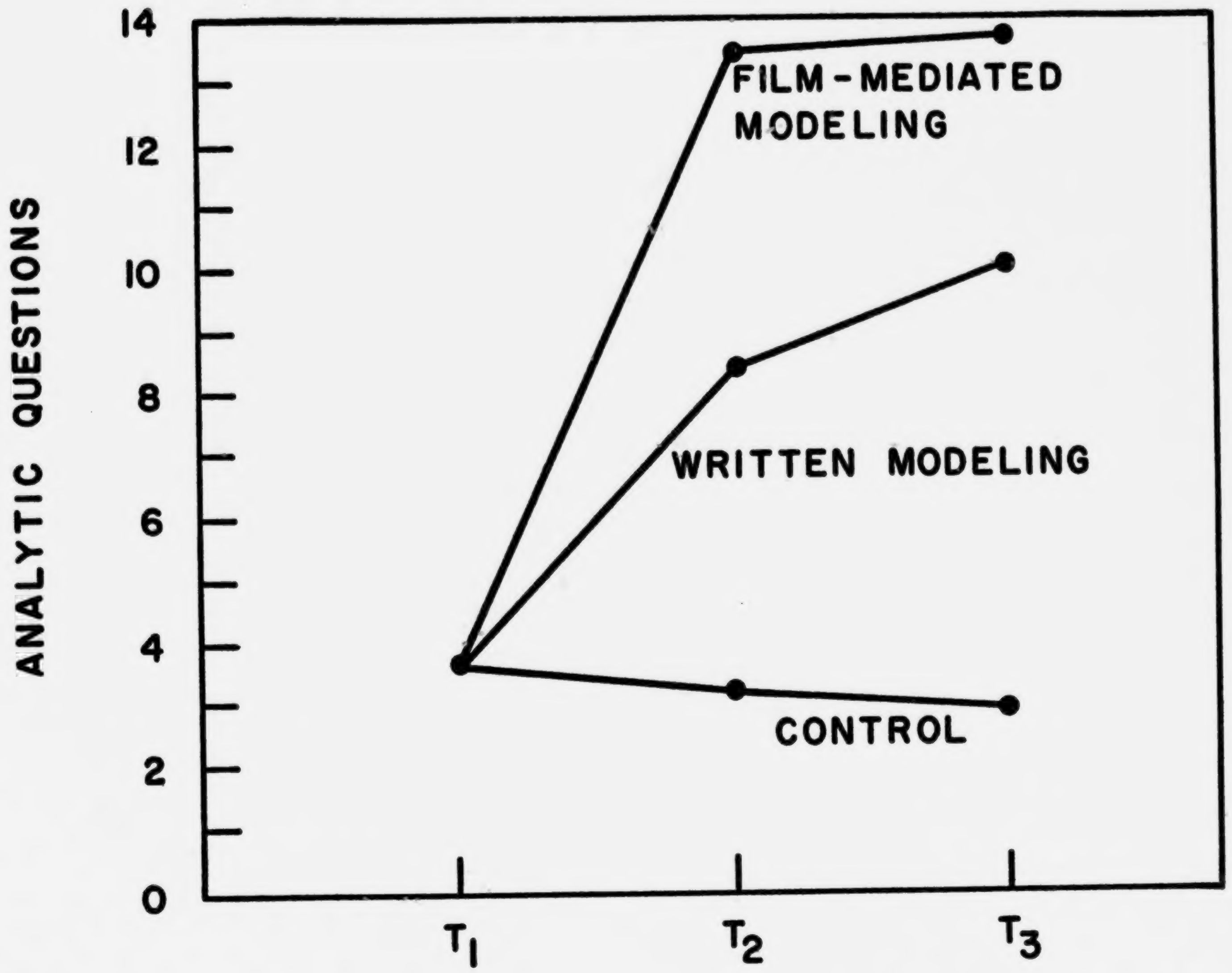

FIGURE 2. MEAN FREQUENCY OF ANALYTIC QUESTIONS ACROSS TEACHING SESSIONS.

Categories of Analytic Questions. Table 11 presents the results for the repeated measures analysis of variance for the variety of categories of *Analytic Questions* used. Since there was a significant interaction ($F = 27.65$, $p < .01$) between treatment groups and teaching sessions, tests for simple main effects were also performed (Table 12). These analyses yielded significant treatment effects both for T_2 ($F = 34.23$; $p < .01$) and for T_3 ($F = 48.21$; $p < .01$). Differences between treatment groups were not found for T_1 ($F = .97$). The specific differences contributing to the treatment effects were therefore investigated by comparisons of pairs of treatments. The comparisons showed that both the Written and Film-Mediated Modeling groups used significantly more categories of *Analytic Questions* both for T_2 and T_3 ($p < .01$) than did the Control group. In addition, *S*s in the Film-Mediated Modeling condition used significantly more categories of *Analytic Questions* ($p < .01$) than did *S*s in the Written Modeling condition for both teaching sessions.

Within-group analyses of change for each group between T_1 and T_3 showed a significant increase in the number of categories of *Analytic Questions* used both for the Written Modeling group ($F = 21.81$; $p < .01$) and

TABLE 11

ANALYSIS OF VARIANCE OF CATEGORIES OF ANALYTIC QUESTIONS

Source of Variation	df	MS	F	p
Between Subjects	119			
Treatment Groups	2	64.79	24.75	.01
Subjects Within Groups	117	2.36		
Within Subjects	240			
Teaching Sessions	2	47.14	54.17	.01
Treatments × Sessions	4	24.06	27.65	.01
Sessions × Subjects Within Groups	234	.87		

TABLE 12

SUMMARY OF ANALYSIS OF VARIANCE OF CATEGORIES OF ANALYTIC QUESTIONS SIMPLE MAIN EFFECTS

Source of Variation	df	MS	F	p
Between Groups				
Treatments at Teaching Session 1	2	1.34	.97	NS
Treatments at Teaching Session 2	2	46.90	34.23	.01
Treatments at Teaching Session 3	2	66.05	48.21	.01
Error Between Groups	351	1.37		
Within Groups				
Sessions of Film-Mediated Modeling	2	75.65	86.95	.01
Sessions of Written Modeling	2	18.98	21.81	.01
Sessions of Control	2	1.84	2.11	NS
Error Within Groups	234	.87		

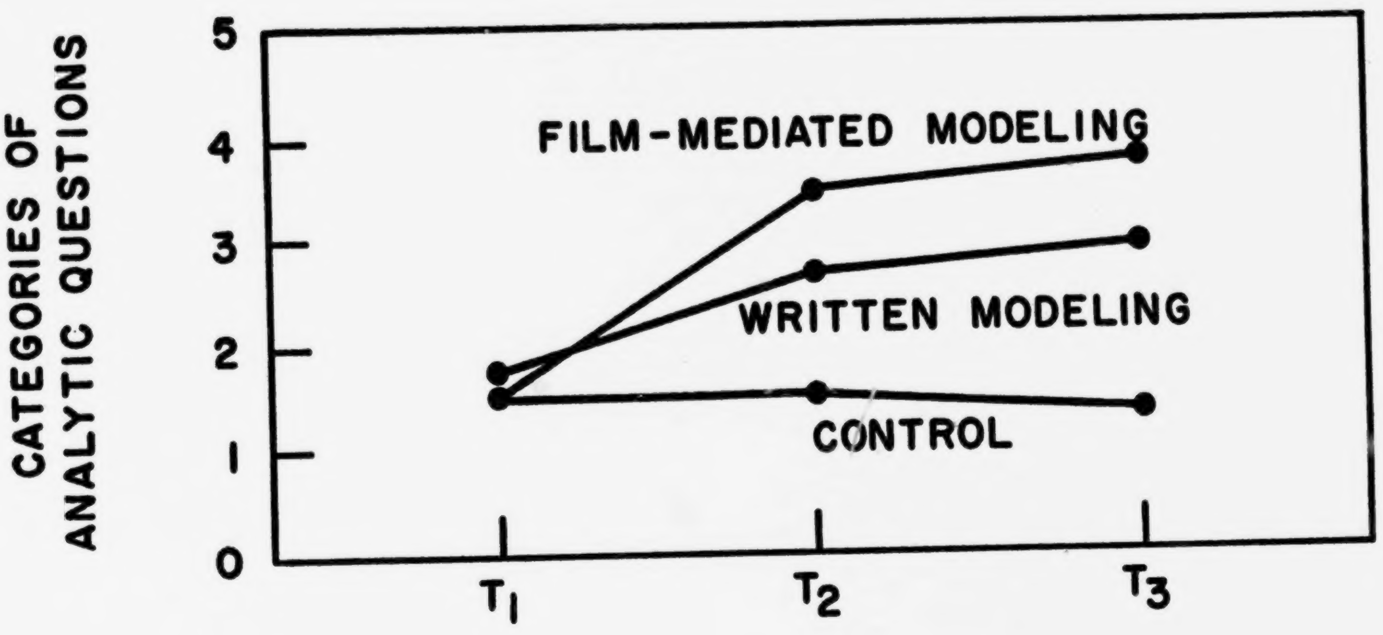

FIGURE 3. MEAN FREQUENCY OF CATEGORIES OF ANALYTIC QUESTIONS ACROSS TEACHING SESSIONS.

for the Film-Mediated group ($F = 86.95$; $p < .01$), while the Control group did not show increases in the number of categories used ($F = 2.11$).

Figure 3 depicts the mean number of categories used by each group for each teaching session.

High Quality Analytic Questions. Results from the repeated measures analysis of variance of the quality of Analytic Questions appear in Table 13. Tests for simple main effects were performed (Table 14) in view of the significant interaction ($F = 32.61$: $p < .01$) between treatment groups and teaching sessions. These tests disclosed highly significant treatment effects for T_2 ($F = 51.37$; $p < .01$) and for T_3 ($F = 57.80$; $p < .01$), while treatment effects were not found for T_1 ($F = .08$). Comparisons between pairs of treatment conditions showed that Ss in both the Written and Film-Mediated Modeling groups generated significantly more high quality Analytic Questions than did Ss in the Control group, both for T_2 and for T_3 ($p < .01$). Similarly, the two modeling procedures proved to be differentially effective, with Ss in the Film-Mediated Modeling group producing significantly more high quality Analytic Questions than did Ss in the Written Modeling group ($p < .01$) for both teaching sessions.

TABLE 13

ANALYSIS OF VARIANCE OF HIGH QUALITY ANALYTIC QUESTIONS

Source of Variation	df	MS	F	p
Between Subjects	119			
Treatment Groups	2	874.83	38.67	.01
Subjects Within Groups	117	22.62		
Within Subjects	240			
Teaching Sessions	2	614.88	79.74	.01
Treatments × Sessions	4	251.48	32.61	.01
Sessions × Subjects Within Groups	234	7.72		

TABLE 14

SUMMARY OF ANALYSIS OF VARIANCE OF HIGH QUALITY ANALYTIC QUESTIONS SIMPLE MAIN EFFECTS

Source of Variation	df	MS	F	p
Between Groups				
Treatments at Teaching Session 1	2	.90	.08	NS
Treatments at Teaching Session 2	2	652.46	51.37	.01
Treatments at Teaching Session 3	2	734.11	57.80	.01
Error Between Groups	351	12.69		
Within Groups				
Sessions of Film-Mediated Modeling	2	906.27	117.39	.01
Sessions of Written Modeling	2	225.52	29.25	.01
Sessions of Control	2	1.83	.32	NS
Error Within Groups	234	7.72		

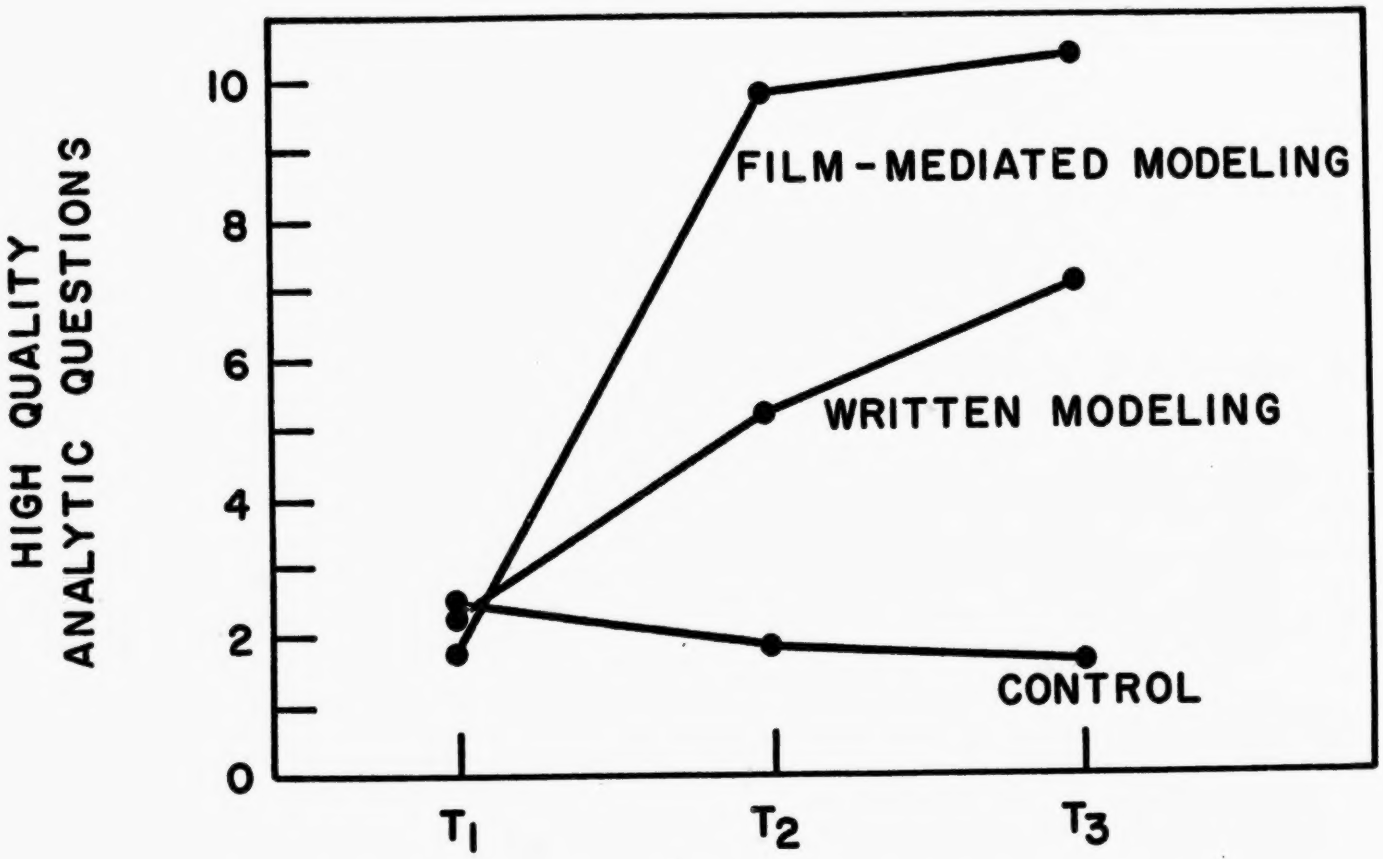

FIGURE 4. MEAN FREQUENCY OF HIGH QUALITY ANALYTIC QUESTIONS ACROSS TEACHING SESSIONS.

Within-group analyses provided another view of the differential effectiveness of the instructional treatments in producing high quality Analytic Questions. Ss in both the Film-Mediated Modeling group ($F = 117.39$; $p < .01$) and Written Modeling group ($F = 29.25$; $p < .01$) displayed significant increases in the number of high quality Analytic Questions, while Control group Ss did not display significant increments ($F = .32$). A visual examination of these modeling effects appears in Figure 4.

Nonanalytic Questions. It was anticipated that treatment effects might manifest themselves by a rise in the frequency of Analytic Questions in some groups and a related decrease in the frequency of Nonanalytic Questions. Table 15 presents the results for the repeated measures analysis of variance of Nonanalytic Questions. Since a significant interaction between treatment groups and teaching sessions was disclosed ($F = 4.47$; $p < .05$), tests for simple main effects were also computed (Table 16). These analyses showed significant treatment effects both for T_2 ($F = 8.04$; $p < .01$) and for T_3 ($F = 12.08$; $p < .01$). Significant treatment effects were not found for T_1 ($F = .38$). Differences contributing to the treatment effects were investigated by comparing pairs of treatments. The comparisons

TABLE 15

ANALYSIS OF VARIANCE OF NONANALYTIC QUESTIONS

Source of Variation	df	MS	F	p
Between Subjects	119			
Treatment Groups	2	1719.19	8.56	.01
Subjects Within Groups	117	200.59		
Within Subjects	240			
Teaching Sessions	2	792.34	14.02	.01
Treatments × Sessions	4	252.68	4.47	.05
Sessions × Subjects Within Groups	234	56.48		

TABLE 16

SUMMARY OF ANALYSIS OF VARIANCE OF NONANALYTIC QUESTIONS SIMPLE MAIN EFFECTS

Source of Variation	df	MS	F	p
Between Groups				
Treatment at Teaching Session 1	2	39.73	.38	NS
Treatment at Teaching Session 2	2	921.11	8.04	.01
Treatment at Teaching Session 3	2	1262.89	12.08	.01
Error Between Groups	351	104.51		
Within Groups				
Film-Mediated Modeling	2	772.13	13.67	.01
Written Modeling	2	550.23	9.74	.01
Control	2	5.60	.10	NS
Error Within Groups	234	56.48		

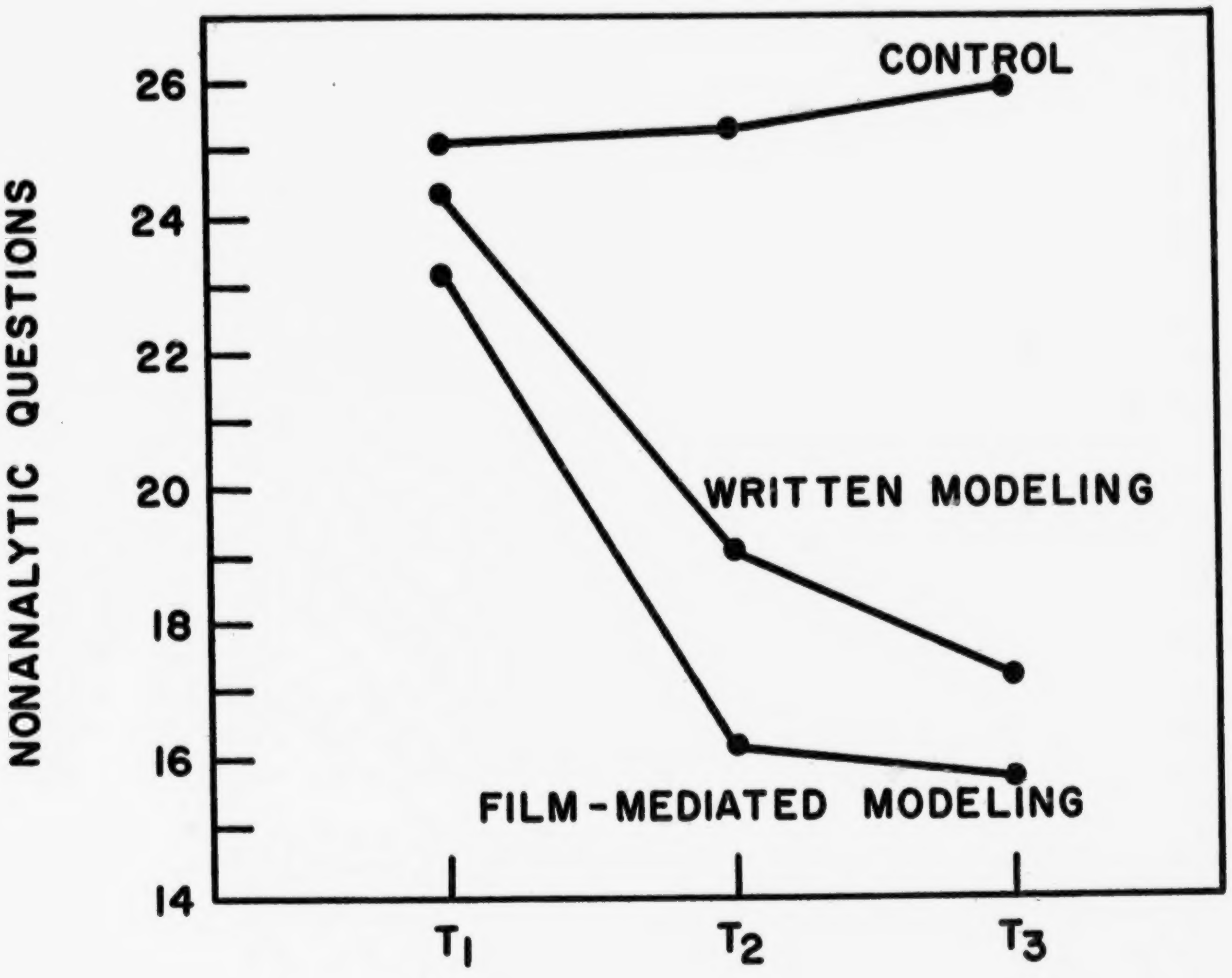

FIGURE 5. MEAN FREQUENCY OF NONANALYTIC QUESTIONS ACROSS TEACHING SESSIONS.

showed that for T_2 and T_3, Control group Ss produced significantly more Nonanalytic Questions than did Ss in either the Written or Film-Mediated Modeling conditions ($p < .01$). However, the Written and Film-Mediated Modeling groups did not differ significantly from one another on either occasion.

Differential treatment effects are also shown by within-group analyses of changes in performance from T_1 to T_3. Ss in the Film-Mediated Modeling group ($F = 13.67$; $p < .01$) and the Written Modeling group ($F = 9.74$; $p < .01$) displayed significant decreases in the number of Nonanalytic Questions used, while Control group Ss did not display such decrements ($F = .10$). It should also be recalled here that Ss in the Written and Film-Mediated Modeling conditions displayed significant increases in the frequency of Analytic Questions, while Control group Ss did not. These modeling effects are illustrated in Figure 5.

Written Measures

As previously indicated, performance on two written measures was obtained in addition to classroom performance measures. The written measures consisted of a True-False Test in which Ss were asked to identify examples and nonexamples of major categories of Analytic Questioning; and a Matching Test, in which subjects were asked to match correctly given questions with categories of Analytic Questions.

A one-way analysis of variance was computed between groups to determine if there were significant instructional treatment main effects for the written measures. Following significant F ratios, the Newman-Keuls procedure was used in comparisons of specific pairs of treatments (Appendix J). Table 8 presents the means and standard deviations of the written measures for each of the three experimental groups.

True-False Test. The results for analysis between treatment groups of scores on the True-False Test are shown in Table 17. A one-way analysis of variance computed between the three groups disclosed significant treatment effects ($F = 20.76$; $p < .01$).

Ss in the Written and Film-Mediated Modeling conditions correctly identified significantly more examples and nonexamples of categories of Analytic Questions than did Ss in the Control group ($p < .01$). However, scores for Ss in the Written and Film-Mediated Modeling conditions did not differ significantly from one another.

TABLE 17

ANALYSIS OF VARIANCE OF SCORES FOR TRUE-FALSE TEST

Source of Variation	df	MS	F	P
Between Groups	2	162.24	20.76	.01
Within Groups	117	7.81		

Matching Test Table 18 presents the results for analysis between treatment groups of scores for the Matching Test. This analysis showed highly significant treatment effects ($F = 32.94$; $p < .01$).

Comparisons between pairs of treatment conditions showed that Ss in the Written and Film-Mediated Modeling conditions correctly matched significantly more items on the test than did Ss in the Control group ($p < .01$). Moreover, Ss in the Film-Mediated Modeling condition obtained significantly higher scores ($p < .05$) than did Ss in the Written Modeling condition.

TABLE 18

ANALYSIS OF VARIANCE OF SCORES FOR MATCHING TEST

Source of Variation	df	MS	F	P
Between groups	2	145.38	32.94	.01
Within Groups	117	4.41		

Ability Measures

Scores on a series of nine ability measures were obtained for 120 Ss included in the analysis. Following the completion of testing, Ss were randomly assigned to the three experimental groups. Table 19 presents the means and standard deviations of these ability measures for the total sample in addition to the composition of the three groups separately.

Frequency distributions of the ability measures were judged to be approximately normal. Thus, normality was assumed for the purposes of further analysis.

Reliability

Reliabilities for all tests used, with the exceptions of Film Memory and the Graduate Records Examination,

TABLE 19

MEANS AND STANDARD DEVIATIONS OF ABILITY MEASURES

	Treatment Group							
	Film-Mediated Modeling		Written Modeling		Control		Total Sample	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Hidden Figures - Part I	6.34	4.00	6.47	3.46	6.10	3.92	6.31	3.77
Hidden Figures - Part II	6.14	3.57	6.87	3.63	6.21	3.59	6.41	3.58
Hidden Figures - Total	12.48	6.75	13.35	6.17	12.31	7.01	12.7	6.61
Identical Pictures - Part I	41.26	8.09	41.70	5.50	40.68	6.54	41.23	6.76
Identical Pictures - Part II	39.83	8.13	41.42	6.56	39.47	6.80	40.25	7.20
Identical Pictures - Total	80.71	14.90	82.62	12.05	79.95	12.27	81.11	13.10
Maze Tracing - Part I	10.10	3.45	11.15	3.18	10.86	4.10	10.70	3.59
Maze Tracing - Part II	13.46	4.07	14.13	3.77	14.63	4.25	14.06	4.03
Maze Tracing - Total	23.56	6.98	25.27	6.46	25.55	7.94	24.77	7.13
Word Arrangement - Part I	19.82	6.71	20.97	6.62	20.18	7.16	20.33	6.79
Word Arrangement - Part II	22.99	7.83	24.30	7.83	21.11	7.54	22.55	7.78
Word Arrangement - Total	41.78	13.63	45.02	13.80	40.89	13.83	42.59	13.75
Verbal Comprehension - Part I	13.68	2.92	14.10	2.58	14.03	2.44	13.93	2.65
Verbal Comprehension - Part II	14.34	3.19	14.35	2.51	14.21	3.07	14.30	2.91
Verbal Comprehension - Total	27.98	5.76	28.40	4.71	28.23	5.18	28.20	5.19
Verbal G.R.E.	611.95	97.06	582.75	158.00	582.36	139.71	592.69	133.27
Film Memory	20.34	3.96	20.80	4.70	19.97	3.12	20.38	3.98
Memory for Ideas - Part I	23.00	6.57	22.90	7.87	22.47	6.04	22.80	6.83
Memory for Ideas - Part II	14.93	5.11	16.05	5.71	13.82	4.35	14.95	5.14
Memory for Ideas - Total	37.85	10.80	38.45	10.20	36.29	9.06	37.55	10.03
Sentence Reproduction - Part I	136.93	17.83	140.85	15.50	137.65	12.49	138.48	15.46
Sentence Reproduction - Part II	139.29	26.69	143.07	30.56	138.23	18.27	140.23	25.67
Sentence Reproduction - Total	276.22	41.01	281.89	34.27	275.89	26.17	278.03	34.36

were estimated from a product-moment correlation between scores on two separately timed parallel parts of each test. The Spearman-Brown formula was used to obtain the reliability coefficients for the full tests.

KR_{20} estimates of realiability for the Graduate Records Examination were available in the manual provided by test publishers. Reliability of Film Memory was also computed using the Kuder-Richardson formula.

Reliabilities for all tests are provided in Table 20, along with a standard error of measurement computed for each ability measure. Reliabilities of factor tests from the French Kit were consistently higher than those of other factor tests used. Reliabilities for the audio-visual tests were acceptable, although somewhat lower.

Intercorrelations of Ability Measures

Intercorrelations of ability measures were computed both for the total sample (Table 21) and for each of the three experimental groups separately (Appendix J).

For the most part, the factor tests display low correlations with one another. This is in accordance with

TABLE 20

RELIABILITIES AND STANDARD ERRORS OF MEASUREMENT FOR ABILITY MEASURES

Test	Reliability	Standard Error of Measurement
Hidden Figures (Cf-1)	.76	3.23
Identical Pictures (P-3)	.83	5.37
Maze Tracing (Ss-1)	.86	2.70
Word Arrangement (Fe-3)	.82	5.77
Advanced Vocabulary (V-4)	.87	1.86
Memory for Ideas	.65	5.91
Sentence Reproduction	.69	19.24
Graduate Records Examination (Verbal Score)	.92	28.00
Film Memory	.50	2.98

TABLE 21

INTERCORRELATIONS OF ABILITY MEASURES: TOTAL SAMPLE

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1. Hidden Figures - Part I		61	90	34	33	34	31	28	32	25	10	17	06	15	12	15	-04	08	-02	04	01	06	02
2. Hidden Figures - Part II			89	33	42	41	25	29	29	25	14	20	10	13	13	07	13	15	07	13	01	08	05
3. Hidden Figures - Total				37	41	42	32	31	34	28	13	21	09	16	13	12	05	12	02	09	01	07	04
4. Identical Pictures - Part I					71	88	38	43	43	21	18	20	27	32	31	27	-04	20	23	25	16	19	19
5. Identical Pictures - Part II						93	43	45	47	08	20	15	25	33	31	24	06	12	18	16	09	13	12
6. Identical Pictures - Total							45	49	50	15	22	20	29	35	34	30	02	17	20	21	11	16	15
7. Maze Tracing - Part I								75	92	07	10	10	09	20	16	30	16	13	19	17	08	10	09
8. Maze Tracing - Part II									94	16	19	20	17	19	19	23	09	04	12	10	02	05	02
9. Maze Tracing - Total										12	16	16	14	21	19	28	13	09	16	14	05	08	05
10. Word Arrangement - Part I											68	89	13	10	12	13	14	24	14	24	08	07	08
11. Word Arrangement - Part II												93	20	19	20	16	06	21	20	25	03	09	06
12. Word Arrangement - Total													18	17	19	17	10	23	18	26	07	10	09
13. Verbal Comprehension - Part I														77	93	48	-02	07	11	11	24	19	25
14. Verbal Comprehension - Part II															94	57	06	09	11	12	32	30	36
15. Verbal Comprehension - Total																56	02	09	12	13	29	27	33
16. Verbal GRE																	03	08	10	10	25	30	32
17. Film Memory																		27	33	37	02	01	02
18. Memory For Ideas - Part I																			48	90	28	31	34
19. Memory For Ideas - Part II																				75	25	15	22
20. Memory For Ideas - Total																					31	28	33
21. Sentence Reproduction - Part I																						53	84
22. Sentence Reproduction - Part II																							87
23. Sentence Reproduction - Total																							

Decimals omitted.

the expectations regarding correlations among factor tests presumed to be independent. However, those factor tests from the French Kit which may be regarded as measures of perceptual abilities (Hidden Figures, Identical Pictures, Maze Tracing) tend to correlate more highly with one another than they do with other tests. These correlations, while low, are consistently significant. Measures of verbal performance display a somewhat weaker tendency to correlate more highly with one another than with primarily perceptual measures.

Relation of Ability Measures to Performance

The major purpose of this study, it will be recalled, was to examine the effects of individual differences on observational learning. In terms of the model previously proposed by Melton (1967) for investigating individual differences in learning, ability-performance relationships may be expected to vary as a function of the nature of the task. It was anticipated that the requirements of the Written and Film-Mediated Modeling conditions were sufficiently different to produce different ability-performance relationships.

A first step in evaluating these theoretically expected relationships was to compute for each group separately, the correlations between all ability and all performance measures. Both part scores and total scores were used for this purpose. These correlations appear in Tables 22, 23, and 24. Upon inspection it was apparent that in several instances the correlations between ability and performance measures varied substantially across treatment conditions. The most promising variables (i.e., those variables which demonstrated the greatest variation among the groups) were then selected for the investigation of aptitude × treatment interactions. Only variables which showed correlations significantly different from zero were used in this analysis.

It should be noted that in several instances, there are substantial differences between the correlations of part scores of a single ability measure with a given performance measure. The most notable example of this can be seen in the part scores for Hidden Figures, where it is obvious that Part I and Part II scores are predicting differentially. Since ultimately we are interested in predicting learning, in cases such as these, part scores rather than total scores have been used in subsequent analysis.

TABLE 22

CORRELATIONS OF ABILITY MEASURES WITH PERFORMANCE MEASURES

FILM-MEDIATED MODELING GROUP

	T_1				T_2				T_3					
	Analytic	Categories	High Quality	Nonanalytic	Analytic	Categories	High Quality	Nonanalytic	Analytic	Categories	High Quality	Nonanalytic	Matching Test	True-False Test
Hidden Figures - Part I	03	08	02	20	-15	-20	-20	05	-25	-49	-20	00	11	16
Hidden Figures - Part II	-13	-14	-11	17	10	-14	00	18	15	-19	06	-04	16	30
Hidden Figures - Total	-05	-02	-05	21	-04	-19	-12	13	-07	-39	-09	-01	15	25
Identical Pictures - Part I	22	35	13	14	-13	-11	-09	27	-13	-10	-14	16	03	18
Identical Pictures - Part II	34	34	32	11	13	-02	13	04	08	05	06	02	04	30
Identical Pictures - Total	31	36	24	17	03	-06	06	08	02	02	00	10	04	28
Maze Tracing - Part I	00	18	03	07	-10	-09	-18	21	-13	-14	-21	19	-22	01
Maze Tracing - Part II	11	21	25	18	-12	-25	-16	23	-07	-13	-08	28	-13	00
Maze Tracing - Total	06	21	16	14	-12	-19	-18	24	-10	-15	-15	25	-18	00
Word Arrangement - Part I	19	22	12	37	-05	-21	-13	40	04	-06	01	56	13	12
Word Arrangement - Part II	21	21	17	40	29	-09	26	39	21	13	21	47	26	30
Word Arrangement - Total	23	26	17	44	14	-17	08	45	15	03	13	56	21	23
Advanced Vocabulary - Part I	28	34	11	33	21	00	11	45	12	14	-01	38	23	11
Advanced Vocabulary - Part II	24	30	07	30	20	03	11	39	05	02	-01	32	33	28
Advanced Vocabulary - Total	27	34	10	34	20	01	10	43	09	07	-02	36	31	21
Verbal GRE	30	43	16	15	17	-05	07	22	-01	-07	-08	27	43	28
Film Memory	-02	01	-01	04	09	01	05	-13	39	34	.44	-03	05	-25
Memory for Ideas - Part I	27	19	09	09	17	21	11	11	06	-10	03	02	07	23
Memory for Ideas - Part II	41	32	35	07	17	08	17	20	10	12	14	07	10	06
Memory for Ideas - Total	41	36	26	11	18	17	15	18	07	-02	07	03	11	19
Sentence Reproduction - Part I	30	14	15	21	22	00	11	12	-11	-23	-17	16	28	-05
Sentence Reproduction - Part II	26	11	13	29	38	19	34	27	14	-09	09	14	19	21
Sentence Reproduction - Total	30	13	15	28	34	12	27	23	04	-16	-02	17	24	11

Decimals Omitted

$r = .26,\ p < .05$

$r = .36,\ p < .01$

TABLE 23

CORRELATIONS OF ABILITY MEASURES WITH PERFORMANCE MEASURES

WRITTEN MODELING GROUP

	T_1				T_2				T_3					
	Analytic	Categories	High Quality	Nonanalytic	Analytic	Categories	High Quality	Nonanalytic	Analytic	Categories	High Quality	Nonanalytic	Matching Test	True-False Test
Hidden Figures - Part I	28	34	18	14	38	29	36	-05	46	35	45	01	30	-20
Hidden Figures - Part II	-08	11	-09	-02	09	01	05	11	-08	-07	-09	02	12	-02
Hidden Figures - Total	11	26	05	07	26	16	23	03	21	15	20	02	24	-14
Identical Pictures - Part I	-02	14	-01	10	08	08	08	-04	13	-06	16	-04	31	-05
Identical Pictures - Part II	-02	21	00	18	03	04	03	18	07	-03	08	07	33	03
Identical Pictures - Total	01	20	02	13	03	02	06	11	05	-08	07	06	34	00
Maze Tracing - Part I	05	01	-01	-30	-02	-09	06	02	10	05	11	-20	25	19
Maze Tracing - Part II	05	12	-11	-23	15	06	19	01	20	24	26	-02	55	41
Maze Tracing - Total	05	07	-07	-28	07	01	14	01	17	16	21	-11	45	34
Word Arrangement - Part I	06	22	-03	06	07	12	03	25	18	25	16	19	09	05
Word Arrangement - Part II	-02	13	-04	00	-02	04	-02	14	06	20	10	07	02	02
Word Arrangement - Total	-01	16	-07	-02	-01	07	-02	21	07	22	10	12	00	04
Advanced Vocabulary - Part I	19	37	13	26	13	-02	18	00	-01	-19	-09	21	08	-09
Advanced Vocabulary - Part II	21	37	11	13	20	08	19	-02	21	-02	10	09	12	00
Advanced Vocabulary - Total	23	37	14	18	14	01	18	-03	08	-16	-01	15	09	-05
Verbal GRE	23	10	15	-01	-11	-06	-07	08	13	-02	01	06	09	-12
Film Memory	-03	08	01	12	08	23	04	20	03	14	-02	02	22	32
Memory for Ideas - Part I	14	18	18	15	17	15	18	-19	07	09	07	-21	08	-24
Memory for Ideas - Part II	15	02	12	22	25	25	22	-08	28	22	23	-22	12	07
Memory for Ideas - Total	12	10	16	20	22	21	22	-17	17	19	15	-24	20	-05
Sentence Reproduction - Part I	15	26	19	-07	29	27	31	-13	19	14	20	-28	25	25
Sentence Reproduction - Part II	24	10	09	-30	14	14	27	-25	13	12	23	-34	22	08
Sentence Reproduction - Total	22	21	18	-24	21	20	29	-23	14	10	21	-38	23	16

Decimals Omitted.

$r = .26,\ p < .05$

$r = .36,\ p < .01$

TABLE 24

CORRELATIONS OF ABILITY MEASURES WITH PERFORMANCE MEASURES

CONTROL GROUP

	T_1				T_2				T_3					
	Analytic	Categories	High Quality	Nonanalytic	Analytic	Categories	High Quality	Nonanalytic	Analytic	Categories	HighQuality	Nonanalytic	Matching Test	True-False Test
Hidden Figures - Part I	17	07	21	01	-04	-14	09	-14	05	03	-04	09	-15	-02
Hidden Figures - Part II	07	01	-02	02	-09	-18	09	-04	00	-02	-02	03	-11	03
Hidden Figures - Total	13	04	11	01	-07	-17	10	-10	03	00	-04	07	-14	03
Identical Pictures - Part I	18	26	19	16	15	09	31	34	18	19	13	29	14	-09
Identical Pictures - Part II	20	22	16	09	09	04	26	22	13	17	17	29	-06	03
Identical Pictures - Total	19	23	18	14	14	06	32	29	17	18	16	31	04	-06
Maze Tracing - Part I	22	28	24	02	30	32	44	02	37	52	33	30	-15	-11
Maze Tracing - Part II	14	21	11	03	12	11	25	17	28	37	28	19	-11	-24
Maze Tracing - Total	18	25	18	02	22	23	36	11	34	47	32	26	-13	-18
Word Arrangement - Part I	05	04	-04	-03	-11	-18	-09	15	09	-01	04	12	07	26
Word Arrangement - Part II	18	-01	17	14	-13	-21	-05	24	21	05	19	29	-01	20
Word Arrangement - Total	15	04	10	07	-11	-22	-07	20	18	04	14	24	03	22
Advanced Vocabulary - Part I	13	-02	11	-30	33	28	20	-23	17	12	09	-05	-25	-05
Advanced Vocabulary - Part II	22	12	09	-29	49	29	38	-19	09	15	-02	06	-05	08
Advanced Vocabulary - Total	19	07	11	-32	45	30	32	-23	13	15	03	01	-15	02
Verbal GRE	20	10	05	-13	37	23	34	-01	14	27	07	03	02	08
Film Memory	23	17	-02	-27	24	22	28	-05	26	39	18	18	18	30
Memory for Ideas - Part I	20	31	21	-04	12	03	09	-02	35	26	33	04	19	07
Memory for Ideas - Part II	04	05	-06	09	-10	-08	-07	07	16	24	17	05	13	05
Memory for Ideas - Total	15	23	11	01	03	-01	03	02	30	29	30	05	19	07
Sentence Reproduction - Part I	-05	-12	-02	-26	-11	-22	-07	-25	04	01	-03	-07	-03	16
Sentence Reproduction - Part II	-01	-10	-13	-14	19	05	-13	-07	12	06	05	-12	14	-05
Sentence Reproduction - Total	-03	-13	-09	-22	07	-07	06	-17	10	05	02	-12	08	04

Decimals omitted.

$r = .26, p < .05$

$r = .36, p < .01$

One possible explanation for the differential functioning of the part scores might center on the nature of the particular tests being considered. These tests are both unique in nature and high in difficulty level. Accordingly, the two parts of the tests can be thought of as two separate trials in a learning task. It is conceivable that differences in part scores reflect psychologically different processes.

Aptitude × Treatment Interactions

Aptitude × treatment interactions were evaluated by comparison of regression slopes for different treatments, using F tests for heterogeneity of regression. Tests were subsequently performed to determine the significance of individual regression slopes for each treatment.

Inherent in the basic theoretical considerations underlying the investigation of aptitude × treatment interactions is educational adaptation to individual differences in the learner. Instruction can be adapted only if there are alternative treatments leading to the same terminal objective, and only if the regression of criterion scores on aptitude scores have the disordinal pattern illustrated in Figure 6 in which the regression line relating aptitude to criterion scores under one treatment intersects the regression line for the alternative treatment (Cronbach, 1965). Consequently, while the results of all regression

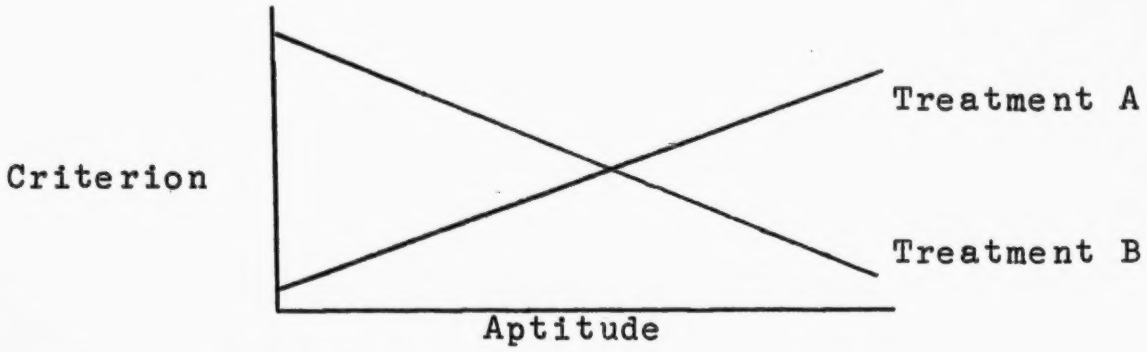

Figure 6. Disordinal Interaction

analyses computed are reported, only the results of analyses in which significant disordinal interactions occurred have been presented in either graphic form or subsequent discussion.

A preliminary step in evaluating aptitude × treatment interactions was to compute regression equations for all ability measures, using scores obtained for both written measures. Of 48 F tests computed to test heterogeneity of regression, 6 significant interactions were found. This step was taken in order to improve procedures for selecting variables for the analysis of aptitude × treatment interactions for classroom performance measures. Of 21 tests for heterogeneity of regression subsequently computed for the classroom performance measures, 7 significant disordinal interactions were found. Thus a considerable improvement in selection can be observed.

However, it should be noted that the latter figure is somewhat arbitrarily low. Tests for heterogeneity of regression were computed for T_1 as well as for T_2 and T_3, even though it was clear that significant interactions were to be found only in the later stages. Moreover, when it appeared that the strength of a relationship between a total test score and a performance measures was largely accounted for by the relationship of one of the part scores to that measure, only the part score was used for regression analysis, even though in some cases the total score would also have produced a significant disordinal interaction.

Classroom Performance Measures

Analytic Questions. Results of regression analyses of aptitude × treatment interactions, using the frequency of Analytic Questions as the criterion measure, are summarized in Table 25. These analyses show that scores on Hidden Figures--Part I produced significant disordinal

TABLE 25

SIMPLE REGRESSION ANALYSES FOR ANALYTIC QUESTIONS

		Treatment Group						
Prediction	Teaching Session	Film-Mediated Modeling		Written Modeling		Control		F
		a	b	a	b	a	b	
Hidden Figures - Part 1	T_1	3.44	.03	2.05	.24	2.90	.14	.64
Hidden Figures - Part 1	T_2	14.90	-.24	4.19	.61**	3.34	.02	4.02*
Hidden Figures - Part 1	T_3	16.08	-.39*	3.87	.96**	2.71	.05	8.25**
Film Memory	T_2	10.60	.14	6.12	.10	-.47	.18	.04
Film Memory	T_3	.96	.62	9.14	.05	-2.57	.28	1.83
Sentence Reproduction-Part 1	T_2	2.66	.08	-6.66	.11	6.22	-.02	1.19
Sentence Reproduction-Part 1	T_3	19.40	-.04	-2.50	.09	1.63	.01	1.37

*p<.05

**p<.01

Note: a and b are of the form: $\tilde{Y} = a + bx$

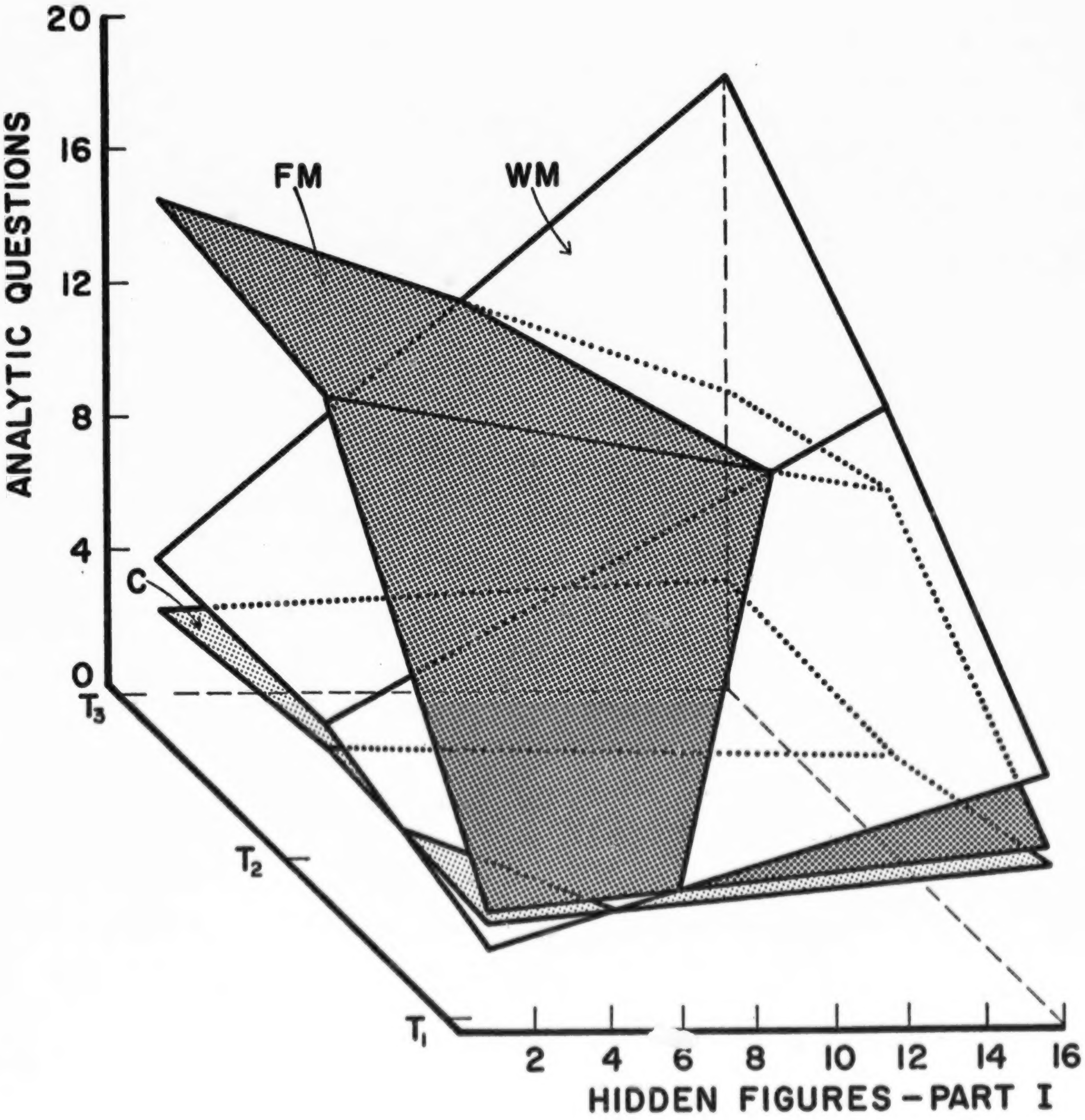

FIGURE 7. INTERACTION OF HIDDEN FIGURES - I SCORES WITH INSTRUCTIONAL TREATMENTS FOR ANALYTIC QUESTIONS.

interactions with the frequency of Analytic Questions both for T_2 ($F = 4.02$; $p < .05$) and for T_3 ($F = 8.25$; $p < .01$); while the interaction for T_1 was insignificant ($F = .64$).

In each case, scores for Hidden Figures were positively related to performance in the Written Modeling condition while negatively related to performance in the Film-Mediated Modeling condition. Thus high ability Ss learned to use Analytic Questions better from the Written Modeling treatment than from the Film-Mediated Modeling treatment, while those scoring low on Hidden Figures profited more from the Film-Mediated treatment. Hidden Figures scores did not display consistent relationship to performance in the Control group. It should be noted that the magnitude of the interactions increased across teaching sessions. The obtained relationship between scores on Hidden Figures--Part I and the frequency of Analytic Questions for the three experimental conditions is illustrated in Figure 7.

Categories of Analytic Questions Aptitude × treatment interactions obtained using the variety of categories of Analytic Questions as dependent variable are shown in Table 26. The results of these regression analyses

TABLE 26

SIMPLE REGRESSION ANALYSES FOR CATEGORIES OF ANALYTIC QUESTIONS

Prediction	Teaching Session	Treatment Group						F
		Film-Mediated Modeling		Written Modeling		Control		
		a	b	a	b	a	b	
Hidden Figures-Part 1	T_1	1.29	.02	1.10	.10	1.64	.02	.97
Hidden Figures-Part 1	T_2	4.11	-.06	2.14	.12*	1.76	-.04	3.28*
Hidden Figures-Part 1	T_3	4.76	-.14**	2.08	.14*	1.30	.01	8.88**
Film Memory	T_2	.09	.07	1.49	.07	.09	.07	.63
Film Memory	T_3	1.05	.12	2.11	.04	-1.05	.12	.78
Sentence Reproduction-Part 1	T_2	3.77	.00	-.51	.02	4.06	-.02	2.37
Sentence Reproduction-Part 1	T_3	5.91	-.02	1.16	.01	1.22	.00	1.54

*$p < .05$

**$p < .01$

Note: a and b are of the form: $\tilde{Y} = a + bx$

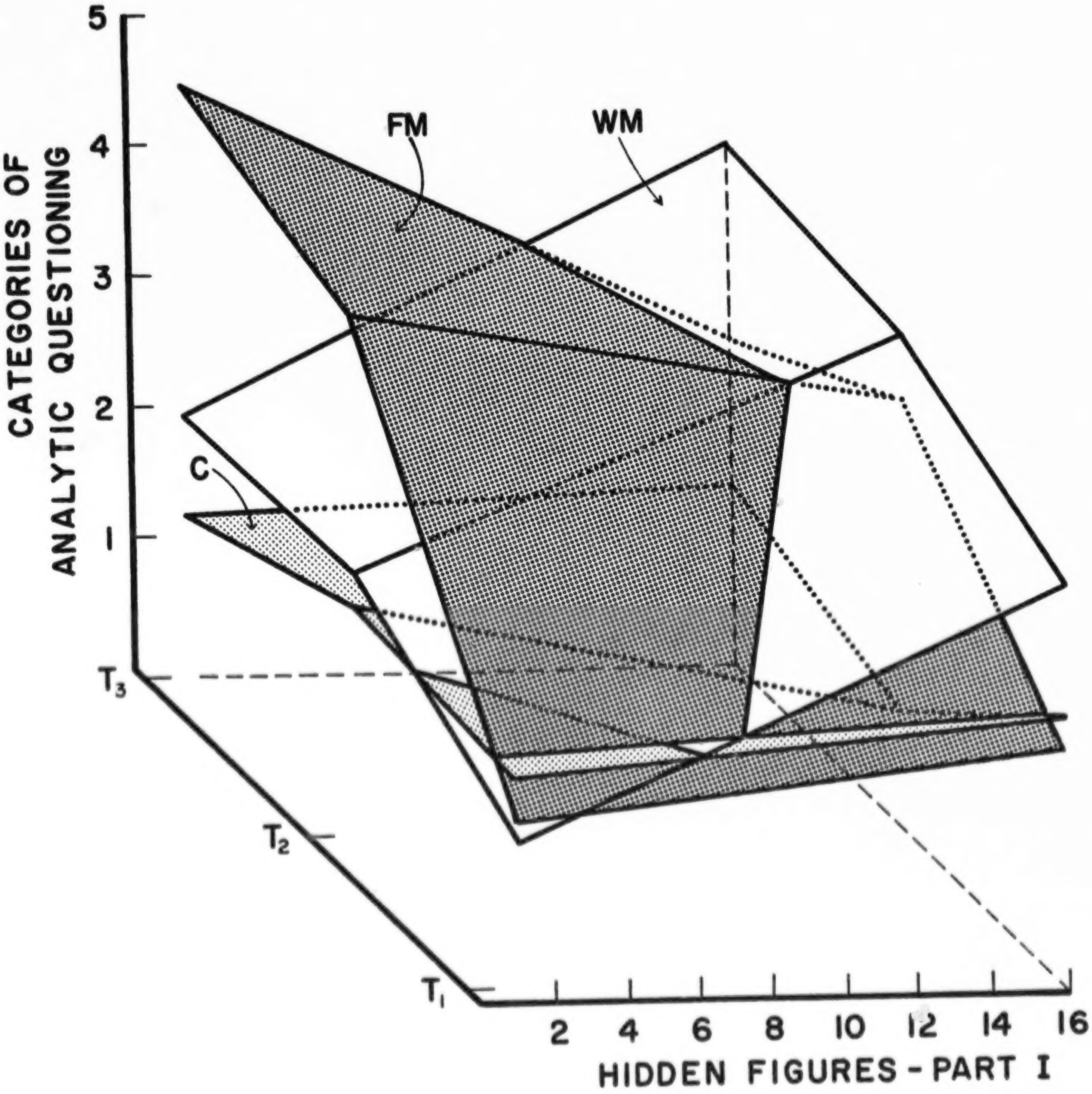

FIGURE 8. INTERACTION OF HIDDEN FIGURES - I SCORES WITH INSTRUCTIONAL TREATMENTS FOR CATEGORIES OF ANALYTIC QUESTIONS.

disclose the interaction of scores on Hidden Figures--Part I with instructional treatment conditions both for T_2 ($F = 3.28$; $p < .05$) and for T_3 ($F = 8.88$; $p < .01$). Hidden Figures scores did not produce significant interaction for T_1 ($F = .97$).

Scores for Hidden Figures were positively related to performance in the Written Modeling condition, while in the Film-Mediated Modeling condition, a negative relationship was obtained between aptitude and outcome. Subjects scoring high on Hidden Figures learned to use a greater variety of Analytic Questions from the Written Modeling condition; those scoring low benefited more from the Film-Mediated Modeling condition. Hidden Figures scores showed little systematic relation to performance in the Control group. The magnitude of the interactions again displayed a tendency to increase across performance trials. These interaction effects are illustrated in Figure 8.

High Quality Analytic Questions The results of regression analyses obtained with the quality of Analytic Questions as the criterion measure are presented in Table 27. These results show that scores on both Hidden Figures--Part I and Film Memory produced significant disordinal interactions with the quality of Analytic Questions used.

TABLE 27

SIMPLE REGRESSION ANALYSES FOR HIGH QUALITY ANALYTIC QUESTIONS

		Treatment Group						
Prediction	Teaching Session	Film-Mediated Modeling		Written Modeling		Control		F
		a	b	a	b	a	b	
Hidden Figures-Part 1	T_1	1.83	.01	1.43	.10	1.43	.12	.49
Hidden Figures-Part 1	T_2	11.54	-.26	2.57	.40*	1.63	.04	4.20*
Hidden Figures- Part 1	T_3	11.89	-.27	3.01	.57**	1.88	-.03	5.70**
Film Memory	T_1	2.02	-.01	1.96	.00	2.52	-.02	.01
Film Memory	T_2	8.53	.07	4.49	.03	-1.02	.14	.10
Film Memory	T_3	-2.38	.62**	7.16	-.02	-.85	.13	4.42*
Maze Tracing-Part 2	T_1	.21	.12	2.86	-.06	1.33	.06	1.19
Maze Tracing-Part 2	T_2	12.64	-.20	2.49	.19	.50	.09	1.76
Maze Tracing-Part 2	T_3	11.61	-.11	2.41	.31	-.48	.15	1.44

*$p<.05$

**$p<.01$

Note: a and b are of the form: $\tilde{Y} = a + bx$

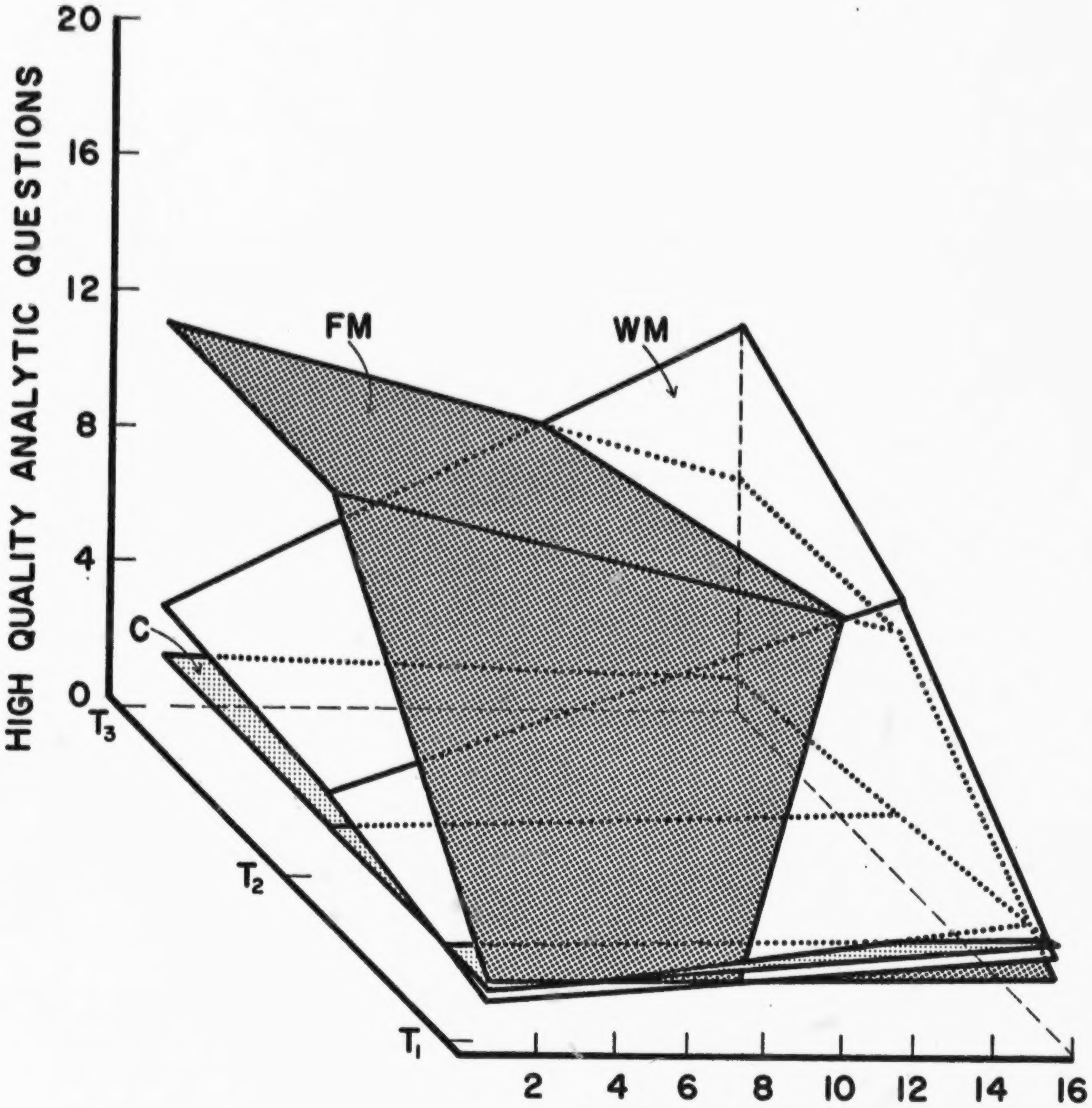

FIGURE 9. INTERACTION OF HIDDEN FIGURES - I SCORES WITH INSTRUCTIONAL TREATMENTS FOR HIGH QUALITY ANALYTIC QUESTIONS

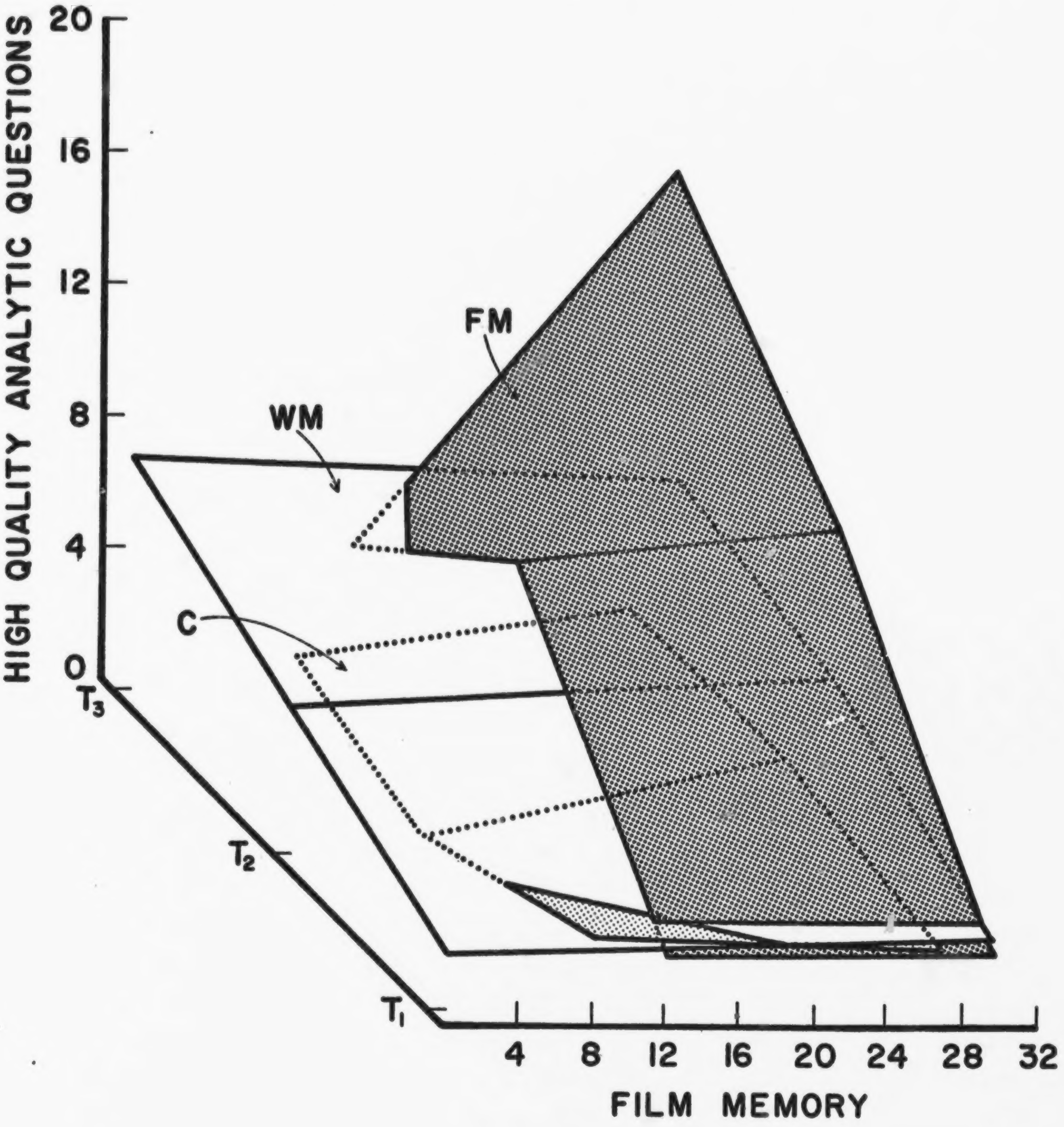

FIGURE 10. INTERACTION OF FILM MEMORY SCORES WITH INSTRUCTIONAL TREATMENTS FOR HIGH QUALITY ANALYTIC QUESTIONS

Hidden Figures scores interacted significantly with the presentation conditions both for T_2 ($F = 4.20$; $p < .05$), and for T_3 ($F = 5.70$; $p < .01$), while the interaction for T_1 was insignificant ($F = .49$). These results were highly similar to those obtained for the frequency and variety of Analytic Questions, with scores for Hidden Figures displaying a positive relationship to performance in the Written Modeling condition and a negative relationship to performance in the Film-Mediated Modeling condition. Again, Ss with high scores on Hidden Figures learned to use high quality Analytic Questions better from the Written Modeling condition, while those scoring low performed better in the Film-Mediated Modeling condition. Hidden Figures scores showed little relation to performance in the Control group. In addition, the interactions tended to increase as instruction progressed. The relationships obtained are depicted in Figure 9.

Scores for Film Memory produced a significant disordinal interaction only for T_3 ($F = 4.42$; $p < .05$). Tests for heterogeneity of regression did not disclose significant interaction either for T_1 ($F = .01$) or for T_2 ($F = .10$). For T_3, Film Memory scores were positively related to performance in the Film-Mediated Modeling condition, while unrelated to performance in either the Written

Modeling condition or the Control group. These results show that Ss with high scores on Film Memory learned to use high quality Analytic Questions better from the Film-Mediated Modeling treatment, whereas low scoring Ss profited more from the Written Modeling Treatment. These interaction effects are shown in Figure 10. In contrast to the interactions previously discussed, this interaction appeared on T_3 with no observable trend in this direction in the previous teaching sessions.

Written Measures

True-False Test Analyses of the interaction of ability measures with treatment conditions for scores on the True-False Test showed that scores for both Film Memory and Maze Tracing--Part II produced significant disordinal interactions (Table 28). Although Film Memory scores interacted significantly ($F = 4.01$; $p < .05$) with scores on the True-False Test, the direction of differences was in contrast to those reported for Film Memory using the quality of Analytic Questions as the dependent measure. This time, the regression slope obtained for the Written Modeling condition was positive, while a negative relation

TABLE 28

SIMPLE REGRESSION ANALYSES FOR TRUE-FALSE TEST

Prediction	Treatment Group						F
	Film-Mediated Modeling		Written Modeling		Control		
	a	b	a	b	a	b	
Hidden Figures - Part I	10.06	.11	10.63	.14	7.03	.01	1.03
Hidden Figures - Part II	9.57	.19	9.88	-.02	7.00	.02	.41
Hidden Figures Total	9.62	.09	10.45	-.05	7.00	.00	1.55
Identical Pictures - Part I	8.19	.06	10.56	-.02	8.13	-.03	1.10
Identical Pictures - Part II	7.81	.07	9.37	.00	6.79	.00	.71
Identical Pictures - Total	7.70	.04	9.71	.00	7.80	.00	1.02
Maze Tracing - Part I	10.75	.00	8.10	.15	11.77	.12	.99
Maze Tracing - Part II	10.74	.00	5.91	.27**	8.58	-.10	4.94**
Maze Tracing - Total	10.74	.00	6.44	.13*	8.14	-.04	3.11*
Word Arrangement - Part I	10.17	.03	9.38	.02	5.70	.07	.16
Word Arrangement - Part II	9.13	.07	9.64	.00	6.04	.05	.27
Word Arrangement - Total	9.46	.03	9.46	.00	5.88	.03	.04
Advanced Vocabulary - Part I	9.48	.09	10.99	-.09	7.65	-.04	.59
Advanced Vocabulary - Part II	7.91	.20	9.81	-.00	6.39	.05	.85
Advanced Vocabulary - Total	8.34	.09	10.57	-.03	6.83	.00	.85
Verbal GRE	7.29	.00	10.77	.00	6.48	.00	1.51
Film Memory	13.09	-.11	6.32	.17*	3.65	.17*	4.01*
Memory for Ideas - Part I	9.15	.07	11.49	-.08	6.62	.02	2.53
Memory for Ideas - Part II	10.40	.02	9.28	.03	6.78	.02	.00
Memory for Ideas - Total	9.38	.04	10.17	-.01	6.53	.02	.53
Sentence Reproduction-Part I	11.67	-.00	4.56	.04	3.73	.02	1.25
Sentence Reproduction-Part II	8.51	.02	8.81	.00	7.83	.00	.47
Sentence Reproduction-Total	9.20	.00	6.31	.01	6.23	.00	.19

*$p < .05$

**$p < .01$

Note: a and b are of the form: $\tilde{Y} = a + bx$

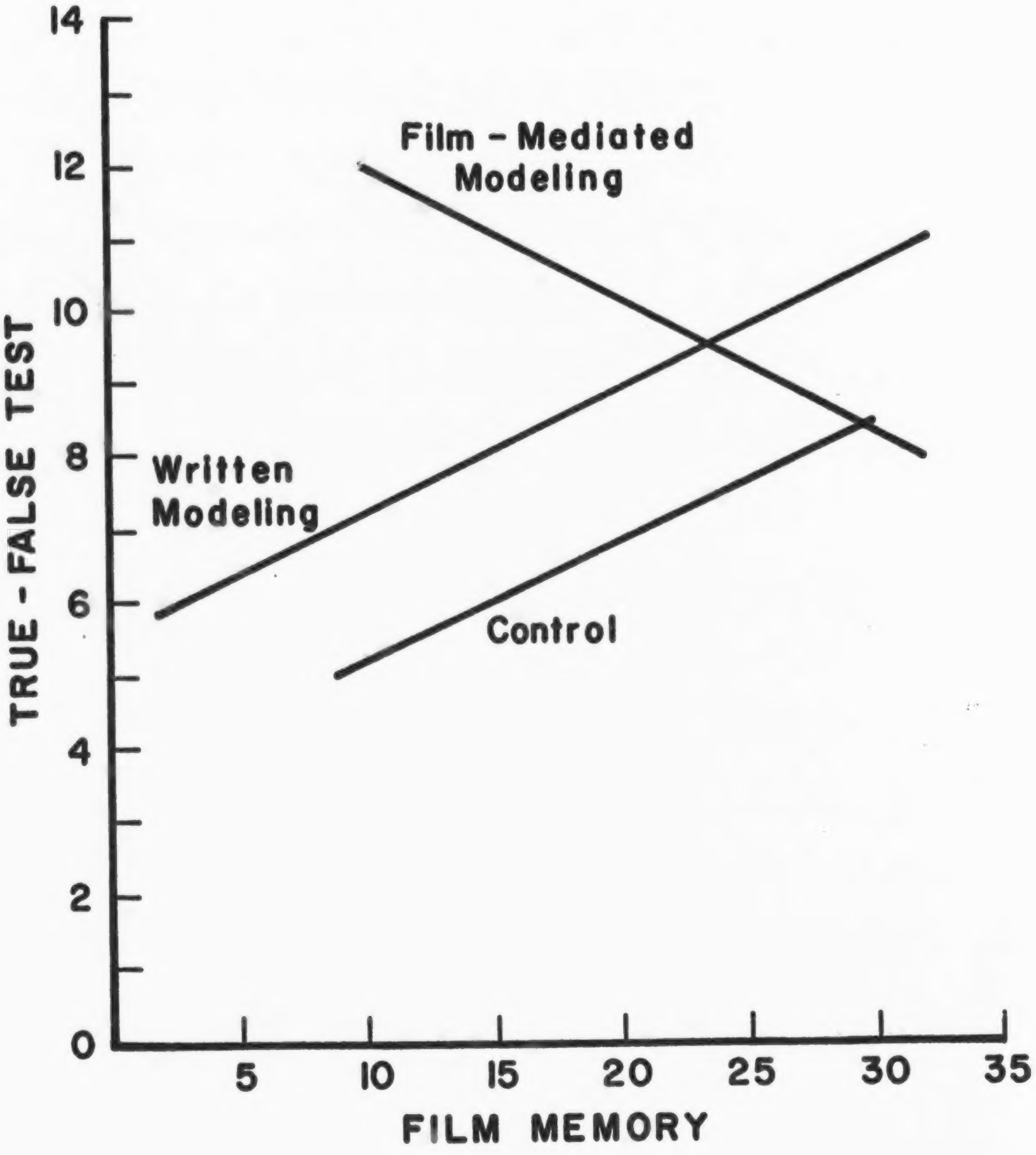

FIGURE II. INTERACTION OF FILM MEMORY SCORES WITH INSTRUCTIONAL TREATMENTS FOR TRUE - FALSE TEST SCORES

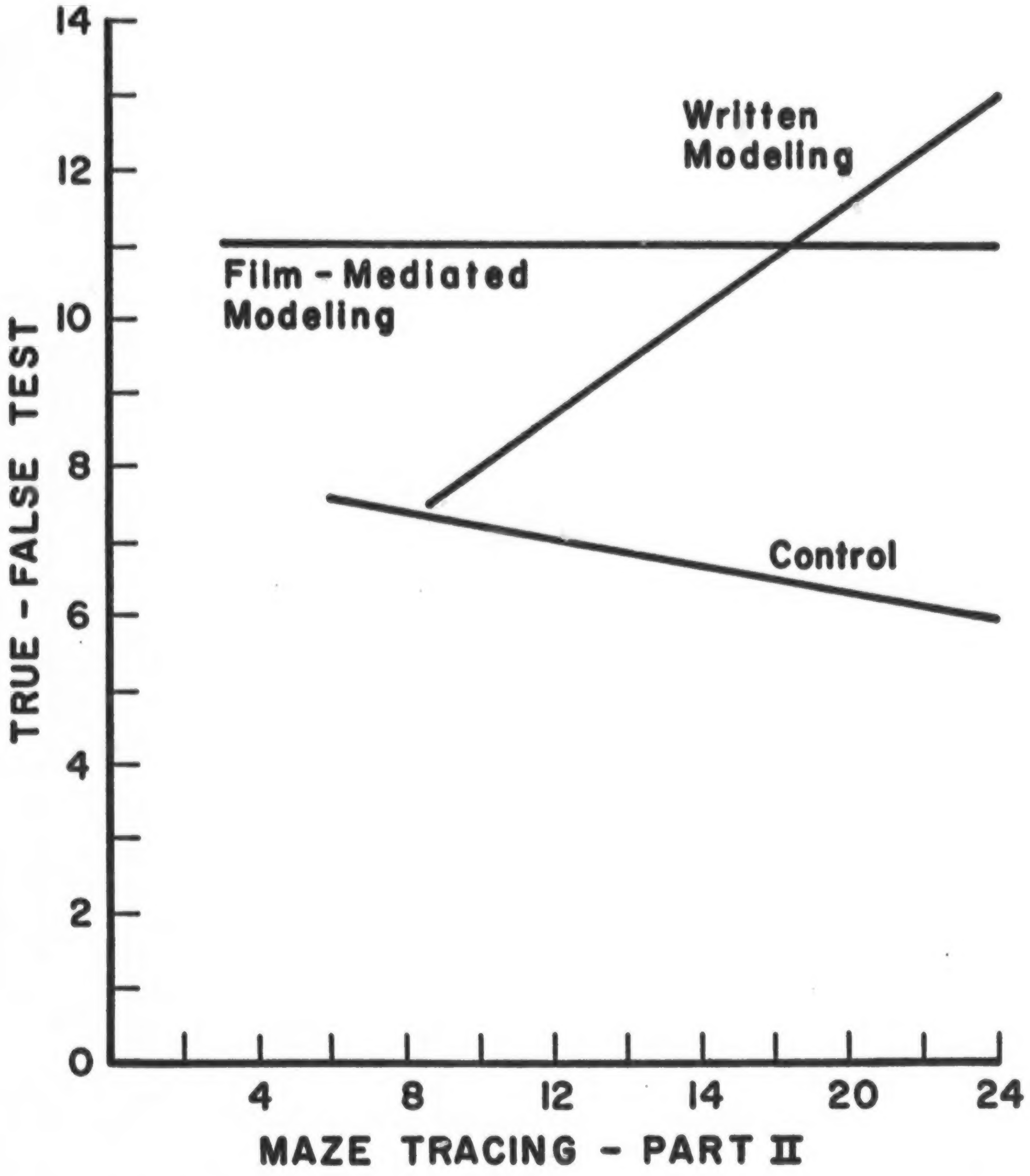

FIGURE 12. INTERACTION OF MAZE TRACING - II SCORES WITH INSTRUCTIONAL TREATMENTS FOR TRUE - FALSE TEST SCORES

was obtained between aptitude and outcome in the Film-Mediated Modeling condition. Thus, high ability S̲s learned to identify categories of Analytic Questions better from the Written Modeling condition; those scoring low on Film Memory performed better in the Film-Mediated Modeling condition.

Scores for Maze Tracing were positively related to performance in the Written Modeling condition, while displaying no relationship to performance in the Film-Mediated Modeling condition. Subjects scoring high on Maze Tracing learned to identify categories of Analytic Questions better from the Written Modeling condition, while low scoring S̲s benefited more from the Film-Mediated Modeling condition. The interaction effects obtained are depicted in Figures 11 and 12.

Matching Test The evaluation of aptitude treatment interactions for scores on the Matching Test showed that both Part II and Total scores for Maze Tracing displayed significant disordinal interactions (Table 29). While both scores for Maze Tracing produced significant interactions, it is clear that the interaction for the Total score ($F = 5.64$; $p < .01$) is largely accounted for

TABLE 29

SIMPLE REGRESSION ANALYSES FOR MATCHING TEST

Predictor	Treatment Group						F
	Film-Mediated Modeling		Written Modeling		Control		
	a	b	a	b	a	b	
Hidden Figures - Part I	11.50	.07	8.84	.26*	8.78	-.12	3.33*
Hidden Figures - Part II	11.25	.11	10.49	.00	8.62	-.09	.50
Hidden Figures - Total	11.26	.05	9.30	.09	8.81	-.06	1.72
Identical Pictures - Part I	11.52	.00	3.47	.17	5.51	.06	1.38
Identical Pictures - Part II	11.15	.02	4.95	.13	9.08	-.03	1.53
Identical Pictures - Total	11.24	.00	3.89	.08	7.26	.00	1.27
Maze Tracing - Part I	13.44	-.15	7.69	.25	9.21	-.11	2.46
Maze Tracing - Part II	12.95	-.08	3.77	.47**	9.09	-.07	7.44**
Maze Tracing - Total	13.40	-.06	4.74	.22**	9.29	-.05	5.64**
Word Arrangement - Part I	10.91	.05	9.87	.03	7.43	.03	.12
Word Arrangement - Part II	9.96	.09	10.70	.00	8.11	.00	1.26
Word Arrangment - Total	10.19	.04	10.51	.00	7.77	.00	.78
Advanced Vocabulary - Part I	9.20	.20	9.23	.09	12.46	-.32	2.43
Advanced Vocabulary - Part II	8.44	.24	7.56	.21	8.76	-.05	1.20
Advanced Vocabulary - Total	8.28	.13	8.44	.07	10.51	-.09	1.83
Verbal GRE	5.52	.01	9.31	.00	7.79	.00	1.08
Film Memory	11.37	.03	7.44	.15	4.67	.17	.36
Memory for Ideas - Part I	11.36	.02	9.69	.04	6.01	.09	.26
Memory for Ideas - Part II	11.17	.05	9.34	.07	6.83	.09	.03
Memory for Ideas - Total	11.03	.02	8.11	.06	5.74	.06	.28
Sentence Reproduction - Part I	6.63	.04	2.99	.05	9.11	.00	.93
Sentence Reproduction - Part II	9.57	.02	7.03	.02	4.87	.02	.05
Sentence Reproduction - Total	7.91	.01	4.29	.02	5.47	.00	.19

$*p<.05$

$**p<.01$

Note: a and b are of the form: $\hat{Y} = a + bx$

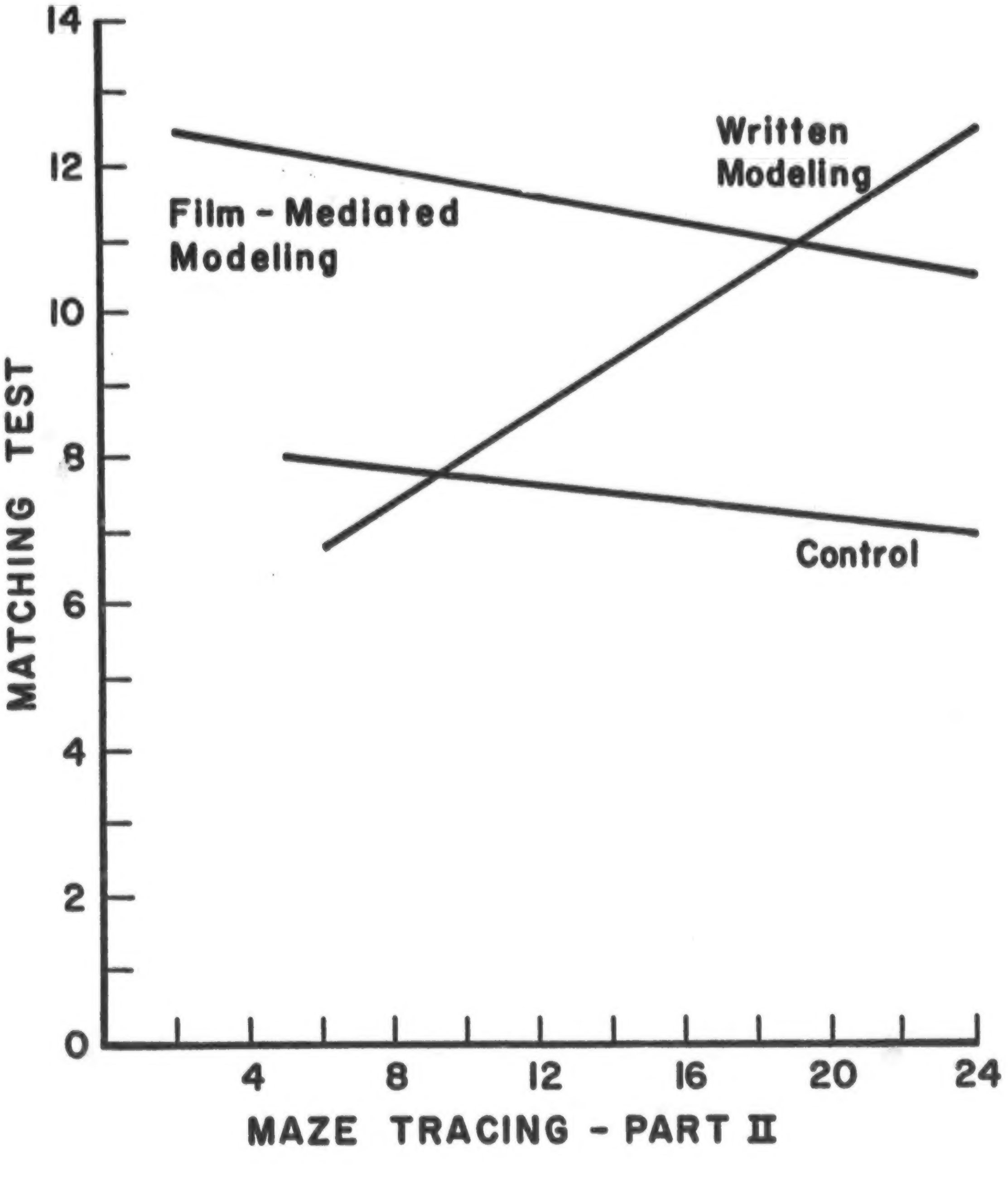

FIGURE 13. INTERACTION OF MAZE TRACING - II SCORES WITH INSTRUCTIONAL TREATMENTS FOR MATCHING TEST SCORES

by the strength of the interaction for Part II scores ($F = 7.44$; $p < .01$). Consequently, since the results are substantially the same for both scores, only the interaction for Part II scores are presented for further discussion and graphic illustration.

Similar to the results for the True-False Test, a positive relationship was obtained between aptitude and criterion in the Written Modeling condition, while scores for Maze Tracing were unrelated to performance in the Film-Mediated Modeling condition and the Control group. Again, Ss with high scores on Maze Tracing learned to identify specific instances of Analytic Questions better from the Written Modeling treatment, whereas those scoring low profited more from the Film-Mediated Modeling treatment. This relationship is illustrated in Figure 13.

CHAPTER IV

DISCUSSION OF RESULTS AND IMPLICATIONS FOR FUTURE RESEARCH

Summary of Data: Hypotheses Tests

This study sought to examine the effects of verbal and perceptual dimensions of individual differences in relation to the efficacy of two different kinds of modeling procedures in the acquisition of a teaching skill. The basic hypotheses tested were:

1. Both Film-Mediated and Written Modeling conditions will produce significantly greater changes in the response strength of desired behaviors than will the Control condition.
2. For subjects receiving the Film-Mediated Modeling condition, criterion scores should show stronger relation to perceptual abilities than for subjects receiving the Written Modeling condition.
3. For subjects receiving the Written Modeling condition, criterion scores should show stronger relation to verbal abilities than for subjects receiving the Film-Mediated Modeling condition.

The general premises from which these hypotheses were derived were:

1. The rate and level of learning of a given teaching strategy varies as a function of model presentation.
2. The effectiveness of instructional methods varies from subject to subject, with such differences being correlated with trainee aptitudes.

Specific predictions, though tentative, were based on theoretical considerations which suggested that the requirements of the Written and Film-Mediated Modeling conditions were sufficiently different to produce different ability-performance relationships.

Instructional Treatment Main Effects

Support for Hypothesis 1 is dependent upon significant between-group differences in measures of the dependent variable. The appropriate statistical tests of this hypothesis are therefore the comparisons of pairs of treatments following an overall significant F ratio.

Data in Tables 9 through 18 strongly support this hypothesis. Following initial written instructions common to all groups, both Written and Film-Mediated Modeling conditions led to significantly higher frequency, variety and quality of Analytic Questioning than did the Control group, and thus to a significantly lower frequency of Nonanalytic Questions also. Similarly, with respect to the written measures, Ss in the Written and Film-Mediated Modeling conditions matched and identified significantly more correct items than did Control group Ss. Significant differences existed between the two modeling conditions and the Control group for all measures of the dependent variable.

It should again be noted that while statistical consideration has been given to several measures of the dependent variable, the strength of association among these measures (Table 7) in some cases is sufficiently high to suggest that these measures do not represent psychologically different variables. However, these variables were analyzed separately in view of differences which existed in ability-performance relationships on some occasions, and because of the unavailability of multivariate analysis of variance techniques.

Additional support for Hypothesis 1 is provided by within group analyses of the changes in Analytic Questioning behavior from base rate to subsequent teaching sessions. This information is provided in Tables 9 through 18. Both Film-Mediated and Written Modeling conditions produced significant increases in frequency, variety and quality of Analytic Questioning, while the Control group did not display such increases. Moreover, both Written and Film-Mediated Modeling conditions produced significant decreases in the frequency of Nonanalytic Questioning, while the Control group did not display such decrements.

The nature of the dependent variable appears to have been an important factor in the results obtained. It has been observed that modeling procedures are most effective in transmitting response patterns which are new or weakly established (Bandura 1965, 1966). Frequently, viable teaching skills and strategies, because of their demonstrable effectiveness in the classroom, can be expected to be occurring in some strength prior to treatment. This raises the question of the utility of modeling procedures for training purposes in such instances. However, the occurrence of Analytic Questioning prior to treatment was found to be surprisingly infrequent. Even following exposure to set induction materials describing the nature of analysis, subsequent questioning was most frequently evaluative rather than analytic. Consequently, the low initial operant strength of Analytic Questioning appears to have provided optimal conditions for demonstrating the effectiveness of the modeling procedures.

A most striking finding was the consistent superiority of the Film-Mediated Modeling condition across all measures of the dependent variable. No specific predictions had been formulated concerning differences existing between the Written and Film-Mediated Modeling conditions. While both of these methods have been effective as training procedures, differences between the two treatments have not consistently been found (Bandura and Mischel, 1965, McDonald and Allen, 1967, McDonald, 1968). However, systematic feedback and reinforcement have often been included in these studies. While the inclusion of these variables has generally contributed to strengthening both modeling treatments, it has perhaps obscured the specific contributions of the observational treatment variable.

This interpretation of the lack of consistency in these results would appear to conform to Bandura's argument that contiguity accounts for the acquisition of matching responses, whereas reinforcement influences the performance of imitatively learned responses (Bandura, 1965). Some evidence on this point has been provided in an experiment in which the introduction of positive incentives completely wiped out previously observed performance differences (Bandura, 1965). In contrast, the exclusion of feedback and reinforcement variables in the present study permitted investigation of the specific effects of an observational experience on the acquisition of a teaching skill.

The clear cut differences between the Written and Film-Mediated Modeling conditions across all measures of the dependent variable supports Carroll's (1959) contention that:

> Psychologists have too often confused the spoken and the written word, or at least they have assumed too freely that spoken and written words are equivalent stimuli (p. 110).

A typed transcript differs from a filmed portrayal in several important respects. A detailed discussion of these differences was given in Chapter I. In addition to providing a behavioral conception of both the teaching skill and lesson pace, the film-mediated portrayal standardizes intonation and stress patterns which subjects may implicitly impose. Differences of this nature may prove to be of considerable importance. Thus, an actual performance is likely to provide substantially more relevant cues with greater clarity than can be conveyed by a verbal description. From the average data alone then, training under Film-Mediated Modeling conditions appears to have been generally more efficient.

Aptitude × Treatment Interactions

Hypotheses 2 and 3 imply disordinal interaction between aptitude and treatment--more specifically, that the regression line relating aptitude to criterion scores under one treatment intersects the regression line for the alternative treatment. The statistical tests of these hypotheses are F tests for heterogeneity of regression.

The evidence with respect to Hypotheses 2 and 3 is mixed. Although aptitude × treatment interactions were obtained, the direction of the interactions did not consistently correspond to predictions. Analyses of aptitude × treatment interactions indicated that scores on Film Memory interacted significantly with the quality of *Analytic Questions*. Scores for Film Memory were positively related to performance in the Film-Mediated Modeling condition, while unrelated to performance in the Written

Modeling condition. Subjects scoring high on the Film Memory Test learned to use high quality Analytic Questions better from the Film-Mediated Modeling treatment, while those scoring low profited more from the Written Modeling treatment. These results are consistent with Hypothesis 2.

In contrast to these findings however, scores on Hidden Figures produced significant disordinal interactions with the frequency, variety and quality of Analytic Questions. While scores on Hidden Figures were positively related to performance in the Written Modeling condition, they were negatively related to performance in the Film-Mediated Modeling condition. Thus high ability Ss learned to use greater frequency, variety and quality of Analytic Questions from the Written Modeling condition than from the Film-Mediated Modeling condition; those scoring low on Hidden Figures learned better from the Film-Mediated Modeling condition. Similarly, with respect to performance on the written measures, scores on Maze Tracing and Film Memory interacted with presentation conditions. Using Film Memory scores, the regression slope obtained for the Written Modeling condition was positive while a negative relation was obtained between aptitude and outcome in the Film-Mediated Modeling condition. Scores for Maze

Tracing were positively related to performance in the Written Modeling condition, while unrelated to performance in the Film-Mediated Modeling condition. These results show that Ss with high scores on Film Memory and Maze Tracing performed better on the written measures in the Written Modeling treatment, whereas low ability Ss benefited more from the Film-Mediated Modeling treatment. These results are in sharp contrast to those predicted. Consequently, Hypotheses 2 and 3 are unsupported by these data. While aptitude × treatment interactions were obtained, the direction of the interactions was not consistent and at times opposite to that hypothesized.

Whenever differences result from a study in contradiction to the hypotheses stated, it is incumbent upon the experimenter to offer post hoc explanation for such differences, although it is not possible, of course, to verify such speculatory explanation within the scope of this study.

The initial hypotheses were based upon an analysis of learning tasks and processes corresponding to a model proposed by Melton (1967) for the investigation of learning and individual differences. An inspection of the individual differences believed to enter at each point in the learning process can be seen in Figure 14. The organization

$$\begin{tikzcd}
 & & r_m(s_m) \arrow[dr] & \\
S_1 \arrow[r] & r_1(s_1) \arrow[ur] \arrow[rr] & & R_aR_bR_c
\end{tikzcd}$$

* Hidden Figures
* Maze Tracing
Identical Pictures
Verbal Comprehension
Verbal GRE

* Film Memory
Memory for Ideas
Sentence Reproduction
Expressional Fluency

Figure 14. Organization of Ability Variables in a Multi-Process Model of Learning

of ability measures within the model has been somewhat arbitrary. Measures such as the GRE Verbal Aptitude scores, with both comprehension and reasoning components, are sufficiently diverse to suggest that there is reason to consider alternative placement. Other measures may also be characterized by similar overlap. However, it should be emphasized that this model has been used as a heuristic device in attempting to select and organize task and ability variables. It is not intended that the present organization be accepted as definitive. Further research will be required to clarify the use of this model.

Of nine ability variables studied, three were found to interact with presentation conditions. If the direction of the interactions is examined with respect to the point in the learning process at which they are believed to enter, certain trends are suggested. Accordingly, it is suggested that such trends may conceivably be interpreted within the framework of the model.

It is becoming increasingly apparent that hypotheses concerning the direction of aptitude × treatment interactions cannot be based exclusively upon superficial content similarities between aptitude tests and learning tasks. Visual or verbal modes of instructional presentation may or may not be related to corresponding scores on perceptual or verbal aptitude tests.

While it would appear that a perceptual mode of presentation would constitute a demand on perceptual encoding systems, the audio-visual presentation could also conceivably serve a compensatory function through the provision of perceptual information that might otherwise be demanded of the subject. Similarly, the lack of audio-visual content in instructional presentation may require subjects to generate their own perceptual detail, thus constituting a demand on the perceptual encoding system.

The stimulus differentiation component of the model is specifically concerned with the encoding process. Of the five ability variables studied here, two were found to interact with presentation conditions. An inspection of the direction of these interactions can be interpreted to suggest that those abilities involved in the stimulus differentiation component may generally serve the compensatory function described above. The purely verbal presentation of a behavioral sequence may require subjects to generate a behavioral conception of that sequence, thus creating a perceptual demand. Conversely, an audio-visual presentation, rich in perceptual detail may require an abstraction of a verbal conception, constituting a verbal requirement.

This compensatory function may be illustrated in the case of those interactions involving Hidden Figures. Performance in this test appears to require subjects to visualize the configurations they are looking for within the context of a given perceptual field. Knowledge of the exact configurations which have to be kept in mind is specially emphasized. Within the Film-Mediated Modeling condition perceptual schema are provided. Ss low in the ability to generate such information for themselves are compensated by this treatment and thereby improve their performance. However, for Ss who are able to generate such schema for themselves, the presentation of such information at a predetermined pace may not only fail to be facilitative.

but may inhibit or interfere with the generation of perceptual information or produce frustration and boredom. An interesting observation was that learners with high scores on Hidden Figures were actually hindered in the Film-Mediated Modeling condition, as demonstrated by the negative relationship between aptitude and performance. The presence of such negative ability-performance relationships may indicate that reliance on a strong ability may lead a learner to choose a strategy which unwisely attempts to exploit that ability in a situation where information is available which would make a different strategy more effective (Bunderson, 1968).

In the Written Modeling condition, where perceptual schema are not provided, Ss high in the ability to generate such information appear to do well, possibly because following their own pace, they can freely generate the needed perceptual information. In contrast, Ss low in ability to generate perceptual information for themselves are not provided with this information in the Written Modeling condition, and subsequently perform less well.

Because of the connection of Hidden Figures with both generalized intellectual ability (Botzum, 1951; Pemberton, 1952) and with a series of tests of a trait called "field independence" (Witkin et al., 1952), there is reason to consider possible alternative interpretations of these results. However, the alternative interpretations are not necessarily inconsistent with the present interpretation. Witkin et al. (1962), in a review of the relevant literature concluded:

> These studies provide impressive support for the view that flexibility of closure and field-independence may be different names for the same dimension. (p. 52)

These findings support Thurstone's (1944) contention that flexibility of closure may be found to represent parameters which transcend the immediate perceptual content in terms of which it had tentatively been identified.

Interactions involving Maze Tracing scores are believed to be more closely related to the pacing factor. Maze Tracing requires speed in scanning a complicated spatial field. In this case, the pace of the film-mediated model may have served as an equalizer in which the predetermined pace of the model imposed a ceiling on the rate at which Ss high in this ability could scan and process information, while being sufficiently slow to allow those Ss low in this ability to profit thereby. Consequently, the correlation between Maze Tracing and performance in the Film-Mediated Modeling condition was attenuated.

In addition, the written model can be characterized as a spatial configuration as well as a verbal configuration. Teacher discourse was identified and separated from student discourse. Questions were set off by question marks and were generally located in certain positions within a paragraph of teacher discourse. Cue discrimination was provided in upper case letters marked by parentheses. _S_s in the Written Modeling condition could determine their own pace without limitations imposed on the speed at which this array of information could be scanned and reviewed. Accordingly, _S_s high in spatial scanning ability could quickly review this written material and locate points at which critical information (i.e., cue discrimination and specific examples of _Analytic Questions_) was given and thereby improve their level of performance. Low ability _S_s might be less able to take advantage of these features.

While these two ability variables are the only variables in the stimulus differentiation component of the model which interacted significantly with instructional presentation conditions, patterns of correlations with respect to other ability variables in the stimulus differentiation component are not inconsistent with this interpretation. Although verbal abilities did not interact significantly with the presentation conditions, the possibility exists that the cue discrimination, in which appropriate verbal labels were provided for critical behavioral sequences served to attenuate the relationship between verbal abilities and performance.

Findings such as these on the relationship of test to task are not unique in the literature on aptitude × treatment interactions (Blaine and Dunham, 1968). Results suggesting a compensatory function of certain task elements have occurred sufficiently often to warrant considering these data relevant to speculations on the relationship of a given aptitude to a particular phase in a learning task.

In contrast to these findings, are the results obtained regarding the response integration component of the model. Of the four abilities studied here, two aptitude × treatment interactions were disclosed. Both aptitude × treatment interactions involved Film Memory in which the findings were in direct contradiction to one another. It will be recalled that the quality of Analytic Questions used was positively related to Film Memory in the Film-Mediated Modeling condition and unrelated to performance in the Written Modeling Condition. Conversely, using scores on the T-F test as the criterion measure, Film Memory was positively related to performance in the Written Modeling condition and negatively related to performance in the Film-Mediated Modeling condition. Although the criteria are clearly different, such apparently contradictory results provide an unsatisfactory basis for conclusions regarding the relationship between the response integration component of the model and the expected direction of aptitude × treatment interactions. However, a supplemental study of another set of dependent measures was undertaken. While these measures were not a part of the main investigation, and thus will not be reported in detail, the results obtained are relevant to clarification of ambiguities in the data reported.

The supplemental set of dependent measures consisted of a recall test in which Ss were asked to list in writing as many Analytic Questions as possible, based on their lesson material, within a 10 minute period. This was collected along with the other two written measures reported, and was rated in a manner identical to that of the classroom performance measures. Analyses of aptitude × treatment interactions for these data disclosed that scores on Film Memory interacted significantly with the frequency and quality of Analytic Questions. In both cases, scores on Film Memory were positively related to performance in the Film-Mediated Modeling condition and unrelated to performance in the Written Modeling condition. Thus Ss scoring high on Film Memory asked higher frequency and quality of Analytic Questions in the Film-Mediated Modeling treatment, while low scoring Ss performed better in the Written Modeling treatment. Similarly, scores on Sentence Reproduction-Part II interacted significantly with the variety of categories of Analytic Questions used. While the regression slope obtained for the Film-Mediated Modeling condition was positive, scores on Sentence Reproduction were unrelated to performance in the Written Modeling condition. Subjects with high scores on Sentence Reproduction learned to ask a greater variety of Analytic Questions from the Film-Mediated modeling condition; those scoring low benefited more from the Written Modeling condition. These findings suggest that in contrast to aptitude × treatment interactions involved in the stimulus differentiation component, aptitude × treatment interactions involving the response integration and memory components of the model may generally be consistent with earlier predictions--more specifically, the relationship of test to task appears direct rather than compensatory, with scores on tests of audio-visual memory related to performance in an audio visual mode of presentation, while unrelated to performance in a written mode of presentation.

It is recognized that this interpretation cannot accommodate the relationship between Film Memory scores and performance on the T-F test. At this time the experimenter is unable to provide a satisfactory explanation for these results on the basis of present data. While it is possible that this finding may be due to chance, an alternative explanation might center on the nature of the task itself. The discriminations required in the T-F test are much coarser than those required for other dependent measures. Conversely, the discriminations required on the Film Memory test are quite fine. An examination of the pattern of correlations suggests that the relationship of ability measures to performance on the T-F test is somewhat different from those obtained with other measures of the dependent variable. It has been suggested (Fitts, 1965) that the perception and encoding of stimuli depend in part upon the required response mode. However, the precise effects of such differences in the nature of a task remain a suitable topic for future investigation.

Information concerning the associational-mediational component of the model is limited. Within the context of this study there were no available measures of ability to generate associative context, analogies, or verbal-behavioral transformation. However, an experimental measure was developed for use in collecting supplemental data which attempted to assess the ability to abstract a verbal conception from a behavioral representation. While scores on this test did not interact significantly with performance on any of the measures reported in the main investigation, these scores did interact significantly with the frequency of Analytic Questions on the recall measure, disclosing a positive relationship to performance in the Film-Mediated Modeling condition and a negative relationship to performance in the Written Modeling condition. These results correspond to those obtained for the response integration component of the model. It should be strongly emphasized, however, that the limited tryout of both content and procedures in addition to the lack of reliability and validity data for this test prohibit the use of this information as anything other than heuristic.

In summary, it has been suggested that the model proposed by Melton (1967) for the investigation of learning and individual differences might be used as a plausible basis for predicting the relationships among learner characteristics and learning outcomes under different instructional procedures, in the manner described above. While the evidence on this matter is not overwhelming, and may be variously interpreted, the model would appear to be useful, at least in a heuristic sense.

An additional finding of considerable interest was the tendency for aptitude × treatment interactions to increase in magnitude across performance trials. This occurred for all interactions involving classroom performance measures. These findings are in contrast to those reported by Woodrow (1938), Fleishman and his associates (1965) and others (Gagné and Paradise, 1961) in which the contribution of cognitive factors in a learning task tended to decrease with practice. This has generally been true both for intellectual and psychomotor tasks.

There are several reasons for such differences. First of all, the type of task that has generally been used has been of relatively short and simple content. This may serve to impose a ceiling on performance which may be reflected in the decreasing contribution of cognitive factors across learning trials. Conversely, the present study has investigated ability-performance relationships across trials on an intellectually complex task. In addition, the conditions of performance in the present study impose a ceiling only in terms of time rather than a fixed format with a limited number of problems, frames, or tasks.

Moreover, this line of investigation has generally been concerned with task variables rather than instructional variables. Accordingly, ability-performance relationships have been assessed under conditions of practice rather than instruction. In contrast, the present study has investigated ability-performance relationships under different instructional conditions.

Thus, the combination of the type of task and instructional conditions may have served to increase the magnitude of aptitude-treatment interactions across trials. It should be noted, of course, that the number of trials was limited. Continuation through further teaching sessions may eventually have resulted in decreasing ability-performance relationships.

Implications for Future Research

This study represents an initial attempt to assess the effects of trainee aptitudes on observational learning in the acquisition of a teaching strategy. The results obtained suggest that additional research evaluating differentiation of instruction in teacher training may be profitable. The surface has barely been scratched in this area. A variety of relevant research questions are suggested by the results of this investigation.

With respect to the use of modeling procedures in teacher training, several important issues have yet to be systematically explored. As Cronbach (1965) has suggested, any meaningful comparison of treatments requires that each treatment be refined into a good representative of its kind. Accordingly, we need to look more cloclosely at the precise nature of effective modeling conditions in order to determine optimal sequencing of instruction and number of cues and exemplars provided, as well as at the effects of varying amounts and types of set induction and practice. Moreover, the question of retention and transfer effects of this training has not yet been examined. A treatment has multiple effects, and the effectiveness of instructional methods may differ for immediate mastery, retention and transfer. Although positive preliminary information has been provided on this point (Bandura and Mischel, 1965) additional research is required.

There appears to be an abundance of teacher behaviors which could ostensibly be used as dependent variables in studies of this type. Anything that a teacher does or says in an effort to promote student learning is a potential skill to be learned by prospective teachers. While the modeling procedures utilized have been successful in transmitting specific skills such as Analytic Questioning, the general validity of these skills for producing changes in pupil behavior has yet to be demonstrated. Although many of these skills possess face validity, attention should be given to the relevance of such teacher variables in terms of their effect on student learning.

With respect to the effects of trainee aptitude on observational learning, several research questions are suggested. The results reported in this investigation indicate that differences in instructional methods facilitated learning in some subjects while inhibiting learning of others, with such differences being related to trainee aptitudes. It has been suggested that the model proposed by Melton (1967) for investigating individual differences in learning might be used as a plausible basis for the prediction of ability-performance relationships. Considerable emphasis has been placed upon the simultaneous consideration of task and process variables. Clearly, additional research is required to evaluate the utility of this model. The extent to which response integration, stimulus differentiation, coding and a variety of mediational processes may be involved in new learning can be experimentally manipulated. In view of the limited information obtained in this study with respect to individual differences in mediational processes, particular attention should be given in the future to this component of the model.

Related to the major question of the utility of the model are several questions concerning the nature of the specific task utilized in this investigation. While the task was relatively complex, the difficulty level was to some extent attentuated through the provision of set induction and cue discrimintation. Although these features are believed to have generally strengthened both modeling conditions under consideration, the question of the extent to which the provision of this additional information altered ability-performance relationships that would otherwise be a function of the exclusive effects of an observational sequence remains unanswered.

In addition, the results of this study have raised the question of the effect of response mode on ability-performance relationships. These relationships differed substantially from classroom performance to written measures. It has been suggested (Fitts, 1967) that the perception and encoding of stimuli depends at least partially on the responses to be made to the stimulus information. Accordingly, it is recommended that further experimental tests of the model include variations in the response mode used by subjects.

Moreover, the question of ability-performance relationships involved in retention and transfer measures on this particular task has yet to be explored. A legitimate question is the extent to which the battery of tests used samples abilities related to retention and transfer as well as immediate mastery.

Finally, further investigation of changes in the contribution of cognitive abilities over practice would appear to be a potentially fruitful line of investigation. Results such as those obtained in this study indicate that this question cannot be answered simply. The effects of variables such as the nature of the task, conditions of instruction or practice, length of the training period and composition of the subject group appear worthy of future investigation.

Implications for Educational Practice

The results of this investigation support the initial premises that the rate and level of learning of a specific teaching strategy varies as a function of model presentation; and that the effectiveness of instructional methods varies from subject to subject, with such differences being related to trainee aptitudes.

Although it has not been demonstrated that the training procedures utilized in this investigation represent the most effective way to train teachers, these findings provide evidence that through observation, trainees can acquire principles exemplified in a model's behavior and use them for generating novel combinations of teaching behavior. The results of these training procedures were sufficiently strong and consistent to suggest that they can be used with reasonable confidence in their effectiveness. Accordingly, this research supports the general recommendation that the use of written and film-mediated modeling procedures is a highly effective means of modifying teaching behavior in training contexts analagous to those described in this experiment. Moreover, while questions concerning interactions between specific teaching behaviors and instructional conditions have yet to be resolved, there is further evidence, from the average data alone, to suggest that film-mediated modeling procedures possess cueing properties which tend to recommend their use over written modeling procedures, at least for establishing Analytic Questioning behavior.

This research does not lead to detailed suggestions for specific modification and developments regarding the individualization of teacher training programs. Experiments such as these have only begun to explore the wide range of problems concerned with finding effective teaching techniques for students with different characteristics. Much research remains to be done before such recommendations can be made with confidence. However, there are both cost and efficiency implications for teacher training in these results. Given replication of these findings, assignment of trainees to alternating treatment is appropriate for maximizing learning. Moreover, the cost of training is reduced considerably as more teachers can be assigned to written rather than film-mediated treatments.

The results obtained in this study appear sufficiently encouraging to suggest the potential value of further research evaluating differentiation of instruction in teacher training. Results such as these, if replicated, may eventually provide a basis for the individualization of teacher training programs.

Limitations and Further Statistical Considerations

While the initial purposes of this investigation have been satisfied, the results obtained generate questions concerning the most appropriate kinds of statistical analyses for research of this type. The analyses used have not been exhaustive. More complete statistical elaboration of these results can and should be pursued. A next logical step would be to combine aptitude variables to describe complex interactions, using multiple rather than simple regression analyses.

Additional methodological issues need also to be considered. While significant disordinal aptitude x treatment interactions have been obtained, the points along the ability continuum at which the effects of instructional procedures clearly become significantly different have not yet been established. One possibility for such analysis lies in the application of the Johnson-Neyman (1936) method in which the continuum of aptitude test scores can be divided into regions where each instructional method is superior.

Moreover, optimal procedures for dealing with multiple instructional outcomes have not yet been determined. Simultaneous statistical consideration of multiple outcomes of instruction is infrequently represented in the literature. In view of the differential importance of multiple criteria, it is not yet apparent what weighting schemes might be most useful when combination is desirable.

It is anticipated that additional analysis of the present data will continue in an attempt to provide information useful in resolving these issues.

APPENDICES

APPENDIX A

RATER MANUAL

RATER MANUAL

I. GENERAL RULES

A. When a teacher is eliciting a student response, he is asking a question.

B. Rate each inquiry as given. Don't add punctuation or extra words even if this seems necessary to "make sense" out of the inquiry.

C. If inquiries have blanks or data indicating something has been omitted, rate anyway as long as the inquiry makes sense.

D. Inquiries such as "What else?" "Can you give another example?" "Anything else?" "Keep going," "What is he saying?" "What is he getting at?" "What about?" "How about?" "Any other?" "Is that what he's saying?" etc., when following an Analytic Question, are considered an extension of that question and are rated as such.

   1. An extension takes precedence over any changes of terms. e.g. "What is meant here by garnering glory?" is a definitional question. "Any other reasons?" is considered an extension of the definition despite the change in terms.

   2. An extension does not refer to a paraphrase, but to the question preceding the paraphrase.

E. In case of a conflict of terms use the first term, e.g. "What assumptions are made about the reason why people riot?" would be rated as an assumption since the assumption precedes the hypothesis here.

F. If a ratable Analytic Question which does not refer specifically to the written material is embedded in a section of teacher discourse which is obviously referring to the article, rate it as Analytic.

G. Questions to be rated as Analytic should be related to the written material rather than simply representing the student's opinion.

e.g. "What does the author mean by patriotism?" would be rated as Analytic, whereas "What is your own definition of patriotism?" would not be.

H. Questioning should be directed to critical analysis of the written material. This should be interpreted fairly liberally, with the benefit of the doubt given in borderline cases. The main distinction is that the teacher should be getting at the analysis of the material--what has actually been set forth--rather than simply asking students for their own opinions, value judgments, etc.

I. Be sure to check to see if the teacher discourse at the top of a page may be a continuation from the bottom of the preceding page--this can make a big difference as to whether the question is to be rated as an Analytic Question or not.

J. Be sure to check all of your totals to see that ALL questions have been rated. This is VERY important.

II. ANALYTIC QUESTIONS

A. Hypotheses

A hypothesis states a relation of dependency among variables. It predicts that a change in one variable will be accompanied by or will produce changes in another variable; thus the relationship may be stated as cause and effect or as accompaniment.

Here are some examples of hypotheses: The characteristics of a college a student attends will be related to the scores he obtains on the GRE. The first variable is "college characteristics"; the second "examination scores." Attitude toward school will be related positively to the amount of biology retained. Attitude toward school is one variable (since not all students have the same attitude), amount of biology retained is another variable. The hypothesis predicts that positive attitudes will be associated with greater retention.

Hypotheses are frequently (but not always) stated in the form: If A, then B: If positive attitude toward school, then greater retention of subject matter.

Includes: Any interrogative sentences or statements that ask what relationship exists between two or more variables.

Examples

1. What is the author's hypothesis?
2. What is the problem that is being investigated?
3. What does he think is the cause of B?
4. What does he think A causes?
5. What is thought here to be the relationship between A and B?
6. How are A and B connected?
7. Is X the hypothesis?
8. What analogy is he stating?
9. Why does he think A happens?
10. What arguments (explanation) does he give for B?
11. How does he account for B?
12. What is he trying to prove?

BOTH SIDES OF THE HYPOTHESIS HAVE TO BE RELATED TO THE ARTICLE.

Does not include: What is theme, or main point.

B. Definitions

The word definition comes from the Latin de which means, "concerning" and "finis," boundary or limits. A definition is therefore literally a statement concerning the limits or boundaries of the meaning of a word. Definitions thus have two main tasks to perform: to convey the essential meaning which is to be the common ground of understanding, and to mark out its limits with sufficient precision for the purposes in view.

Includes: Questions requiring students to distinguish the methods and standards used for defining a word in terms of the written material they are analyzing (as distinguished from their own opinion or common sense notion), similarities, differences, definitions by example.

Examples

1. What is meant here by poverty?
2. A proposed civil rights bill would apply to business engaging in a "substantial" amount of interstate commerce. How is substantial defined here?

3. What is meant here by patriotism?
4. How do we know what a hippie is from reading this?
5. How does he define objective?
6. Does he define hippie?
7. What distinctions does he make between militaristic and pacifistic patriotism?
8. What does he say is the difference between prejudice and discrimination?
9. Who are the hippies? (who here referring to a collective)
10. How does the author define poverty with respect to income level?
11. What examples does he give of patriotism?

Does not include: "Who" when who is an individual rather than collective. Describe is not included unless the question is something like "describe what he means by hippie," or unless words other than describe are added to give it additional meaning.

C. Assumptions

Includes questions requiring students to identify assumptions being made which can only be inferred from an analysis of a series of statements.

Includes: Questions asking for the identification of an element regarded as that which is assumed, inferred, implied, presupposed, taken for granted, underlying, behind, underneath, etc.

Examples

1. What assumptions are being made in this argument?
2. What is he inferring about the race riots?
3. Is he implying X?
4. What inferences are being made here?
5. What is being taken for granted (presupposed) here?
6. What must be assumed to underlie that?
7. What is behind (underneath) that argument?

D. Distinction of Fact from Opinion or Value Judgment

These questions require students to detect the nature and function of a particular statement in a communication.

Includes: Questions requiring students to distinguish factual evidence in an argument from opinions or value judgment. (Value judgments refer to the good-bad, approve-disapprove, for-against dimension.)

Examples

1. What facts are being presented here?
2. What evidence is given in support of the hypothesis?
3. How does the author feel about X?
4. What does he think about X?
5. What is his idea on this?
6. What is his opinion here?
7. Is X a fact/ opinion/ value judgment?
8. What does he cite as evidence?
9. What does he use to defend/back up this hypothesis?
10. What information was that based on?

Does not include: Just because the author said it does not make it a fact.

E. Conclusions

Questions requiring students to distinguish a proposed conclusion arrived at from supporting statements.

Includes: conclusions, answer, solution, summary point, resolution, final decision arrived at, suggestion made to deal with, alternative solutions to a problem, ways proposed to deal with a problem, suggestions to deal with a problem, etc.

Examples

1. What conclusion does he come to?
2. What answer does he arrive at about what the hippies should do?
3. Is X the conclusion? (Is that what he is saying? Does he say that?)

4. When he says X, what logical conclusion is he arriving at?
5. How does he answer the original question?
6. How does he propose to deal with that problem?
7. What alternatives to that solution does he offer?

III. QUALITY DIMENSION

A. Identification of Hypotheses - Questions requiring a statement of a relation of dependency among variables.

1. Questions of high quality require students to supply both variables involved in the relationship in addition to the relationship itself.

    a. What is the hypothesis being investigated?
    b. What is the author trying to prove?
    c. What relationship is the major premise of his argument?

2. Questions which do not meet the criteria established for high quality include questions in which the student must supply only one (or part) of the variables, and/or the relationship itself;

    a. What does A cause?
    b. Why does B happen?
    c. What is C associated with?
    d. What is the relationship between A and B?

    and questions requiring only that the student agree, disagree, or select from among given alternatives.

    a. Is X the hypothesis?
    b. Is X or Y or Z the hypothesis?

B. Identification of Definitions - Questions requiring students to distinguish the methods and standards used for defining a word.

1. Questions of high quality require students to supply key elements of the definition and their methods of measurement.

    a. A proposed civil rights bill would apply to business engaging in a "substantial" amount of interstate commerce. How is "substantial" being defined here?
    b. What does the author mean by patriotism?

2. Questions which *do not* meet the criteria established for high quality include questions in which a key element or method of measurement is given;

    a. How does the author use the word poverty with respect to income level?
    b. How does the author define patriotism in its military sense?
    c. With respect to the amount of tar and nicotine content, how does the author define a "revolutionary filter"?

    and questions requiring only that the student agree, disagree, or select from among given alternatives.

    a. Is X what is meant here by revolutionary?
    b. With respect to social class, does the author mean income, education, or occupation?

C. *Identification of Assumptions* - Questions requiring students to supply both the assumption and its source (what it concerns or is in regard to).

1. Questions of high quality require students to supply the assumption and its source.

    a. What is implicit in his argument?
    b. What assumption is the author making here?

2. Questions which *do not* meet the criteria established for high quality include questions in which students are directed to the source of the assumption;

    a. What assumption is he making about the nature of man?
    b. What inferences are being drawn about what is of prime importance to minority groups?

    and questions requiring only that the student agree, disagree, or select from among given alternatives.

    a. Is he assuming X or Y about Z?
    b. Is A the assumption being made?

D. Distinction of Factual from Nonfactual Statements - Questions requiring students to distinguish the nature and function of a particular statement in a communication as fact, opinion, or value judgment.

1. Questions of high quality require students to supply the fact/opinion/value judgment in its entirety.

    a. What evidence is presented in support of the hypothesis?
    b. What facts are given?
    c. What value judgments are being made?
    d. What is the author's opinion of that?

2. Questions which do not meet the criterion established for high quality include questions in which part of the relevant information is given;

    a. What facts are cited about the success of current heart transplants?
    b. What value judgment is being made about the lack of validity in the hippie movement?

    and questions requiring only that the student agree, disagree, or select from among given alternatives.

    a. Does he think X about Y?
    b. Is X a fact?
    c. Is his opinion X or Y?

E. Identification of Conclusions - Questions requiring students to distinguish conclusions from supporting statements?

1. Questions of high quality require students to supply a conclusion in its entirety.

    a. What conclusion did the author arrive at?
    b. What solution to the problem is being suggested?
    c. What alternatives has he suggested to that answer?

2. Questions which do not meet the criterion established for high quality include questions in which part of the information relevant to the conclusion;

    a. What conclusion did the author come to on what responsible dissenters should do?

b. What answer does the author arrive at as to which is the better kind of patriotism?

and questions requiring only that the student agree, disagree, or select from among given alternatives.

a. Is the author suggesting that disease prevention is the alternative to heart transplants?
b. Is his solution to the racial problem integration, strengthening of the black community, or both?

APPENDIX B

SET INDUCTION MATERIALS

STANFORD UNIVERSITY
School of Education

Technical Skills Project
Director: F. J. McDonald

Prepared by Mary Lou Koran
Training Instructions for:

The Development of Analytic Questioning

PLEASE READ THE FOLLOWING INSTRUCTIONS VERY CAREFULLY BEFORE TEACHING YOUR FIRST LESSON.

Educators hold that one of the major objectives of instruction in the schools is the development of skills or strategies which will enable students to become lifelong autonomous learners. While the content of any field may undergo rapid change, the ability to analyze written materials within that content area is a skill which is always an objective of any field of study. One way of developing such ability in students is to train teachers to ask the kinds of questions that require students to engage in analytic thinking with respect to their reading material. The objective of this training session is to help you develop the skill of asking these kinds of questions.

Analytic Questioning

A communication is composed of a large number of elements. Some of these elements are explicitly stated in the communication and can be recognized and classified relatively easily.

There are other elements in a communication which are not so clearly labeled or identified by the writer. These elements can be inferred only from an analysis of a series of statements within the communication. Many of these elements may be of great importance in determining the nature of the communication. Until the reader can detect them he may have difficulty in comprehending and evaluating the communication.

Analytic questioning breaks a communication down into its critical elements or parts such that the function of these elements within the communication, as well as the relative hierarchy of ideas, is made clear. Such analyses are intended to clarify the structure of the communication, to indicate how it is organized, and to identify the arrangement of ideas in it.

YOUR GOAL IS TO TEACH A LESSON IN SUCH A WAY AS TO ASK QUESTIONS WHICH LEAD STUDENTS TO IDENTIFY AND CLASSIFY THE CRITICAL ELEMENTS OF THE WRITTEN COMMUNICATION YOU HAVE BEEN GIVEN.

The written material you have been given is meant to serve as a vehicle for analytic questioning. Using the *skill* of analytic questioning is the objective of the lesson rather than transmitting content.

APPENDIX C

WRITTEN MODEL

TEACHER: We are dealing with an essay by Archibald McLeish called "When We Are Gods." You have all had a chance to read this closely now. An essay, a piece of writing, in fact, any communication can be thought of as a number of elements together; and usually in a complex interrelationship. So in order to understand the elements that make up a communication, we need to do some critical analysis. We need to identify these elements, single them out and consider what they are doing in the essay, how they are contributing to the meaning. So we are going to try to do that with five categories that relate to the basic thinking process. In fact, this could be a piece of scientific writing, it could be from a history text book. As it is, it is an editorial by a philosopher and poet. (NOTICE THE CATEGORIES OF ANALYTIC QUESTIONS TO BE USED.) The five categories that we are going to apply to it are: hypotheses, the difference between statements of fact and statements of value, unstated assumptions that he may be making, definitions and how he is making it known what he means by certain words, and conclusions that he reaches in the course of his reasoning. The categories again are: hypothesis, fact value statements, basic assumptions, definitions, and conclusions. (NOTICE HOW HE ASKS FOR HYPOTHESES.) Let's begin with that first category because we could look for a very broad hypothesis.

STUDENT: I think the idea of the essay is sort of centered around a paradox that he finds and he brings out in the first paragraph of the rest of the essay. And the paradox being: why in this advanced age of ours with all of our great technological advances, why is man and most of humanity still despondent and why does it still feel a great deal of despair over its own existence.

TEACHER: Okay. He centers then on that paradox. The question seems to be why the triumph on one side, the uneasiness of humanity on the other. And notice that he organizes the essay around those two sides: the triumph on the one side, uneasiness on the other. Can you see within the rest of the essay any place where he seems to be stating another or perhaps a related hypothesis?

STUDENT: In the third paragraph the first sentence fits nicely into an "if then" statement. If, in the terms of scientific and industrial accomplishments, then our age is one of the great ages of history.

TEACHER: Okay. And we can see this as a hypothesis that he goes on to develop and give some evidence for. (NOTICE HOW HE ASKS FOR THE DISTINCTION BETWEEN FACT AND VALUE JUDGMENT.) If we look at it from industrial scientific standpoints, this is one of the great ages of history. Does he give any facts in relation to this statement? Does he refer to anything that we could call facts rather than value judgments? or opinions?

STUDENT: In the first paragraph, the fact could be the President's statement about that nobody seems to see what is right with America, only what was wrong with it. A value judgment or a conclusion can be one of the President's. "What was right," he said, "was obvious and admirable." And then the rest of the essay would probably consist mainly of value judgments on the part of the author.

TEACHER: Okay. Now this is an editorial and I think that is a very important observation, Debby, that values seem to be throughout it. That he is making some value judgments. What are some specific value judgments that he seems to make in the course of the essay?

STUDENT: Well, he makes several through the whole essay. There is one very blatant one on the second page; It says, "in most ages it is the arts which are creative and believe; the men of action who despair." And then he goes on to say that the arts usually see the truth. And this is a pretty extreme assumption, although it may be true.

TEACHER: Okay. The arts see the truth. If that were a statement of fact we would be able to prove it. If it is a statement of value, it would express something that men believe in. I think we can see that distinction. (NOTICE HOW HE ASKS FOR DEFINITIONS.) Now, when he gets into talking in the second half of the essay, notice he is talking about the uneasiness and he uses the term "despair." Does he anywhere in the essay give us what we could consider a definition of despair? What is he talking about when he says "despair"? Cris?

STUDENT: Uh, I think one probably could say that he says that discoveries of contemporary literature are old discoveries long since made and then he says, the discovery that men each really die and the discovery that moral human life is meaningless. He realizes that man is human and that he realizes that he does possess this technological power, and that he does realize that he can destroy himself.

TEACHER: Okay. He has defined despair then as the feeling based on these discoveries--old discoveries long since made. Notice him giving examples there for definition too because he defines the old discoveries long since made. How does he define old discoveries long since made?

STUDENT: Well, he gives specific examples of these discoveries.

TEACHER: Right. (NOTICE HOW HE ASKS FOR ASSUMPTIONS.) And that he defines right within the context as we read what he means. Would you say that over all in his writing that there is any basic unstated assumption, or premise that he would pretty much hold in mind but not be stating directly. Think about that. What do you think? Ken?

STUDENT: Possibly the assumption, uh, that the reader is fairly well read in mythology because he brings out several instances, especially near the end, where he brings up Greek Mythology, such as man stealing fire from the gods. And also he brings up an analogy of Hercules in the end.

TEACHER: Good. In fact, notice in both cases that he doesn't refer to the name of the god, the one myth of Prometheus, and he doesn't refer to the name of Hercules or Heracles. Although he just refers indirectly so we can conclude that he is assuming some familiarity with myths. Can you see other basic unstated assumptions within the essay?

STUDENT: Well, kind of, in the next to the last paragraph he says, "we know what we are" and this seems to imply that maybe man has a tendency towards self destruction, that no matter what happens we'll end up losing ourselves.

TEACHER: Good. We know what we are. That almost has a frightening sound to it--we know what we are. (NOTICE HOW HE ASKS FOR CONCLUSIONS.) What then would you say is the conclusion toward which the whole paper moves and would be an answer to the overall problem that he is posing What is the conclusion?

STUDENT: Well, in the last paragraph in his last sentence which would be the final statement that he makes, he says, like the old Greek here, who we've already defined as Hercules, who learned when all his labors had been accomplished--that's when all his achievements had been made--that would be paralleling Hercules to now, to us, when all our achievements have been made. That it was he himself who'd killed his sons and that we would kill our sons, our future with all our achievements--maybe the atom bomb or other nuclear weapons.

TEACHER: Good. And that bringing in the myth at the end, you see, especially to someone familiar with the myth, would raise a kind of frightening idea: The old Greek completing his labors; Hercules completing his labors just like science completes its labors and then going insane and killing the future, killing his sons. Overall then, we see McLeish reasoning through, giving in many cases poetic examples. And let's see if we can summarize very quickly and see for instance how all that we've said in a way relates to the hypotheses. What was the major hypothesis that he dealt with?

STUDENT: Why is there this paradox of great achievement and at the same time despair.

TEACHER: Right. Why the. . .why the achievement on one side and yet the almost total despair. And notice how each part of the essay relates to trying to answer that question. Either to justify his statement that there has been great triumph in technological scientific areas, or to show the despair--and then toward the end to answer "Why." And basically, that answer, why the despair, is what?

STUDENT: Uh, man is afraid of self-destruction. . .

TEACHER: Right.

STUDENT: . . .afraid of his power.

TEACHER: Man is afraid of self-destruction, afraid of his power. . .

STUDENT: We know what we are. . .

TEACHER: We know what we are. A good sentence to close with--we know what we are.

APPENDIX D

WRITTEN MEASURES

Below is a list of kinds of questions possible for classroom use. Place a "T" or "F" in the space provided at the left of each item number according to whether or not it represents a major kind or category of Analytic Questioning.

___ 1. Identification of observations

___ 2. Identification of experimental procedures

___ 3. Identification of hypotheses

___ 4. Identification of inferences

___ 5. Identification of theories

___ 6. Identification of conclusions

___ 7. Identification of unstated assumptions

___ 8. Identification of predictions

___ 9. Identification of factual vs. nonfactual statements

___ 10. Identification of manipulation or control of variables

___ 11. Identification of generalizations

___ 12. Identification of semantic definitions

___ 13. Identification of intent of author

___ 14. Identification of the classification of objects or observations

Below is a list of the five major categories of Analytic Questioning followed by a list of questions. Identify which of the categories each question fits into by writing the number of the category in the space provided at the left of the sentence. If a question does not correspond to any of the given categories, leave the space blank.

1. Identification of hypotheses
2. Identification of factual vs. nonfactual statements
3. Identification of assumptions
4. Identification of semantic definition
5. Identification of conclusions

____ What does the author believe has caused an increase in the use of narcotics?

____ Into which categories would Hemingway's writing fall?

____ What is the writer's opinion on that question?

____ A proposal for a civil rights bill would apply to businesses engaging in a substantial amount of interstate commerce. What is meant here by substantial?

____ Which statement is the logical outcome of his argument?

____ How could you predict the form of the written material if you knew its function?

____ Could you state something that you believe is true for all of these cases?

____ What statement constitutes the major premise of the argument?

____ What would happen if I increased the temperature of the water?

____ What does the author think is the relationship between poverty and crime?

____ What is the answer to that question in your own opinion?

____ What kind of an experiment could you set up to test the theory that form determines function?

____ What inference could you make from these observations?

____ How does the writer feel about student demonstrations?

____ What underlying belief is implicit in this argument?

____ What information would we need to have about that?

____ What can be inferred in the data from which Galileo extrapolated the case for free fall?

____ What examples are given here of "poverty and deprivation"?

APPENDIX E

RATING FORMS

RATING FORMS

NAME:

DATE:

SCRIPT:

TOTAL ANALYTIC QUESTIONS	______
Hypotheses	______
Definitions	______
Assumptions	______
Fact - Nonfact	______
Conclusions	______
TOTAL CATEGORIES	______
TOTAL HIGH LEVEL	______
TOTAL NONANALYTIC QUESTIONS	______

NAME:

DATE:

SCRIPT:

ANALYTIC QUESTIONS

	Total
HYPOTHESES:	
High Quality	
Low Quality	
DEFINITIONS:	
High Quality	
Low Quality	
ASSUMPTIONS:	
High Quality	
Low Quality	
FACT - NONFACT:	
High Quality	
Low Quality	
CONCLUSIONS:	
High Quality	
Low	

NONANALYTIC QUESTIONS

Total

APPENDIX F

INTERCORRELATIONS AMONG DEPENDENT VARIABLES

INTERCORRELATIONS AMONG DEPENDENT VARIABLES
FILM-MEDIATED MODELING GROUP

		2	3	4	5	6	7	8	9	10	11	12	13	14
1	Analytic Questions, T_1	80	83	17	33	20	33	00	13	07	17	-05	07	16
2	Categories, T_1		72	15	11	11	17	11	01	01	04	03	-07	19
3	High Quality, T_1			15	26	06	29	-10	16	09	27	-11	00	07
4	Nonanalytic, T_1				13	-20	11	43	08	-17	11	54	08	06
5	Analytic Questions, T_2					53	92	14	52	50	50	02	22	26
6	Categories, T_2						54	-05	27	49	27	-26	-08	30
7	High Quality, T_2							07	44	50	48	-03	12	20
8	Nonanalytic, T_2								-04	-08	-18	64	-07	11
9	Analytic Questions									68	91	-18	24	25
10	Categories, T_3										66	-16	07	12
11	High Quality, T_3											-23	26	25
12	Nonanalytic, T_3												07	-05
13	True-False Test													33
14	Matching Test													

Decimals omitted

INTERCORRELATIONS AMONG DEPENDENT VARIABLES
WRITTEN MODELING GROUP

		2	3	4	5	6	7	8	9	10	11	12	13	14
1	Analytic Questions, T_1	78	87	12	48	32	54	-20	50	38	47	-09	14	-37
2	Categories, T_1		70	21	52	34	51	-18	41	32	37	-02	23	-17
3	High Quality, T_1			17	42	29	49	-13	37	19	39	-03	00	-40
4	Nonanalytic, T_1				29	23	20	00	35	15	29	25	18	-11
5	Analytic Questions, T_2					77	94	40	69	52	67	24	48	-04
6	Categories, T_2						73	-42	56	58	58	-33	47	10
7	High Quality, T_2							-42	60	44	62	-29	46	-06
8	Nonanalytic, T_2								-30	-23	-26	58	-22	-04
9	Analytic Questions, T_3									74	91	-19	46	-06
10	Categories, T_3										73	-27	48	17
11	High Quality, T_3											23	46	-06
12	Nonanalytic, T_3												-07	-04
13	True-False Test													49
14	Matching Test													

Decimals omitted

INTERCORRELATIONS AMONG DEPENDENT VARIABLES
CONTROL GROUP

		2	3	4	5	6	7	8	9	10	11	12	13	14
1	Analytic Questions, T_1	72	79	12	46	42	43	12	70	55	59	37	08	00
2	Categories, T_1		61	17	39	40	35	15	47	39	42	34	-04	-05
3	High Quality, T_1			18	27	31	37	02	68	44	68	32	-09	-11
4	Nonanalytic, T_1				-17	-12	-09	58	12	02	17	49	16	-29
5	Analytic Questions, T_2					79	73	-01	47	53	28	18	00	03
6	Categories, T_2						66	00	47	60	32	35	-12	-18
7	High Quality, T_2							-07	46	47	38	25	00	-12
8	Nonanalytic, T_2								15	07	17	58	18	-03
9	Analytic Questions, T_3									79	91	45	16	-03
10	Categories, T_3										68	43	-10	-01
11	High Quality, T_3											38	-19	00
12	Nonanalytic, T_3												-05	-07
13	True-False Test													.24
14	Matching Test													

Decimals omitted

APPENDIX G

ANALYSES FOR HOMOGENEITY ASSUMPTION

SUMMARY OF REGRESSION ANALYSES BETWEEN TEACHING SESSIONS

Variables	Treatment Group						F	p
	Film-Mediated Modeling		Written Modeling		Control			
	a	b	a	b	a	b		
Analytic Questions, T_1-T_2	11.10	.64	4.89	.90	1.84	.40	1.05	NS
Analytic Questions, T_2-T_3	6.59	.52	2.88	.88	.99	.59	2.14	NS
Analytic Questions, T_1-T_3	12.70	.25	5.79	1.18	.17	.74	3.15	.05
Categories of Analytic Questions, T_1-T_2	3.55	.12	2.07	.47	.90	.39	1.13	NS
Categories of Analytic Questions, T_2-T_3	2.06	.48	1.32	.57	.49	.53	.16	NS
Categories of Analytic Questions, T_1-T_3	3.83	.01	2.22	.44	.65	.39	2.02	NS
High Quality Analytic Questions, T_1-T_2	8.49	.74	3.11	1.00	1.19	.33	1.46	NS
High Quality Analytic Questions, T_2-T_3	5.09	.51	2.98	.72	.70	.51	.64	NS
High Quality Analytic Questions, T_1-T_3	8.73	.76	4.83	.91	.19	.68	.14	NS
Nonanalytic Questions, T_1-T_2	6.04	.43	19.42	-.01	11.0	.57	3.64	.05
Nonanalytic Questions, T_2- T_3	6.47	.56	8.36	.46	7.74	..72	1.12	NS
Nonanalytic Questions, T_1-T_3	4.50	.47	11.07	.25	10.07	..62	1.60	NS

Note: a and b take the form: $\tilde{Y} = a + bx$

VARIANCE-COVARIANCE MATRICES

	Control			Written Modeling			Film-Mediated Modeling		
ANALYTIC QUESTIONS									
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
T_1	9.40	3.35	7.15	9.02	8.17	10.73	11.37	7.25	2.79
T_2	3.35	5.65	3.68	8.17	31.28	22.63	7.25	41.06	21.42
T_3	7.15	3.68	10.85	10.73	27.63	50.61	2.79	21.42	40.08
CATEGORIES OF ANALYTIC QUESTIONS									
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
T_1	1.08	.44	.40	1.03	.48	.45	1.27	.16	.01
T_2	.44	1.08	.61	.48	1.93	1.11	.16	1.42	.68
T_3	.40	.61	.94	.45	1.11	1.89	.01	.68	1.36
HIGH QUALITY ANALYTIC QUESTIONS									
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
T_1	4.96	1.33	3.46	3.60	3.60	3.31	4.11	3.06	3.11
T_2	1.33	2.50	1.38	3.60	14.78	10.68	3.06	27.05	13.83
T_3	3.46	1.38	5.20	3.31	10.68	19.60	3.11	13.83	30.54
NONANALYTIC QUESTIONS									
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
T_1	114.89	67.17	68.45	87.16	-1.06	22.04	88.66	38.04	41.94
T_2	67.17	116.39	81.78	-1.06	132.05	61.27	38.04	87.16	49.45
T_3	68.45	81.78	165.37	22.04	61.27	83.84	41.94	49.45	66.70

APPENDIX H

ANALYSES OF VARIANCE
CLASSROOM PERFORMANCE MEASURES

ANALYSIS OF VARIANCE OF ANALYTIC QUESTIONS

Source Variation	df	MS	F	p
Teaching Session 1				
Between Groups	2	.16	.02	NS
Within Groups	118	10.01		
Teaching Session 2				
Between Groups	2	1030.26	39.13	.01
Within Groups	118	26.32		
Teaching Session 3				
Between Groups	2	1191.01	35.25	.01
Within Groups	118	33.80		

ANALYSIS OF VARIANCE OF CATEGORIES OF ANALYTIC QUESTIONS

Source of Variation	df	MS	F	p
Teaching Session 1				
Between Groups	2	1.34	1.13	NS
Within Groups	118	1.18		
Teaching Session 2				
Between Groups	2	46.91	31.47	.01
Within Groups	118	1.49		
Teaching Session 3				
Between Groups	2	66.05	47.13	.01
Within Groups	118	1.40		

ANALYSIS OF VARIANCE ON HIGH QUALITY ANALYTIC QUESTIONS

Source of Variation	df	MS	F	p
		Teaching Session 1		
Between Groups	2	.90	.22	NS
Within Groups	118	4.25		
		Teaching Session 2		
Between Groups	2	652.46	45.46	.01
Within Groups	118	15.01		
		Teaching Session 3		
Between Groups	2	734.12	39.69	.01
Within Groups	118	18.49		

ANALYSIS OF VARIANCE OF NONALYTIC QUESTIONS

Source of Variation	df	MS	F	p
		Teaching Session 1		
Between Groups	2	39.73	.41	NS
Within Groups	118	97.45		
		Teaching Session 2		
Between Groups	2	921.11	8.35	.01
Within Groups	118	110.34		
		Teaching Session 3		
Between Groups	2	1262.89	12.17	.01
Within Groups	118	103.80		

ANALYSIS OF VARIANCE OF ANALYTIC QUESTIONS

Source	df	MS	F	p
Film-Mediated Modeling Group				
Teaching Sessions	2	1335.51	65.62	.01
Persons	39	51.82		
Residual	78	20.35		
Written Modeling Group				
Teaching Sessions	2	442.00	29.86	.01
Persons	39	61.33		
Residual	78	14.79		
Control Group				
Teaching Sessions	2	6.30	1.60	NS
Persons	39	18.50		
Residual	78	3.93		

ANALYSIS OF VARIANCE OF CATEGORIES OF ANALYTIC QUESTIONS

Source	df	MS	F	p
Film-Mediated Modeling Group				
Teaching Sessions	2	75.65	70.70	.01
Persons	39	1.92		
Residual	78	1.06		
Written Modeling Group				
Teaching Sessions	2	18.98	20.40	.01
Persons	39	2.99		
Residual	78	.93		
Contol Group				
Teaching Sessions	2	1.83	3.15	NS
Persons	39	2.13		
Residual	78	.58		

ANALYSIS OF VARIANCE OF HIGH QUALITY ANALYTIC QUESTIONS

Source	df	MS	F	p
Film-Mediated Modeling Group				
Teaching Sessions	2	906.27	65.19	.01
Persons	39	33.91		
Residual	78	13.89		
Written Modeling Group				
Teaching Sessions	2	225.52	33.16	.01
Persons	39	24.40		
Residual	78	6.79		
Control Group				
Teaching Sessions	2	2.50	1.18	NS
Persons	39	8.72		
Residual	78	2.11		

ANALYSIS OF VARIANCE OF NONANALYTIC QUESTIONS

Source	df	MS	F	p
Film-Mediated Modeling Group				
Teaching Sessions	2	772.12	20.10	.01
Persons	39	167.30		
Residual	78	37.86		
Written Modeling Group				
Teaching Sessions	2	550.22	7.47	.01
Persons	39	155.85		
Residual	78	73.60		
Control Group				
Teaching Sessions	2	5.60	.10	NS
Persons	39	274.95		
Residual	78	57.73		

APPENDIX I

TESTS ON MEANS USING NEWMAN-KEULS PROCEDURE CLASSROOM PERFORMANCE MEASURES

ANALYTIC QUESTIONS - TEACHING SESSION 2

Treatment Groups		1. Control	2. Written	3. Film Mediated
Ordered Means		3.32	8.16	13.40
Differences between pairs	1.		4.84**	10.08**
	2.			5.24**
$S_{\overline{A}} = .77$			r_2	r_3
q .95			2.80	3.36
q .99			3.70	4.20
$S_{\overline{A}}q$ .95			2.15	2.58
$S_{\overline{A}}q$ .99			2.85	3.23

*$p < .05$

**$p < .01$

ANALYTIC QUESTIONS - TEACHING SESSION 3

Treatment Groups		1. Control	2. Written	3. Film Mediated
Ordered Means		2.93	10.09	13.58
Differences between pairs	1.		7.16**	10.65**
	2.			3.49**
$S_{\bar{A}} = .77$			r_2	r_3
q .95			2.80	3.36
q .99			3.70	4.20
$S_{\bar{A}}q$ .95			2.15	2.58
$S_{\bar{A}}q$ .99			2.85	3.23

$*p < .05$

$**p < .01$

CATEGORIES OF
ANALYTIC QUESTIONS - TEACHING SESSION 2

Treatment Groups		1. Control	2. Written	3. Film Mediated
Ordered Means		1.59	2.89	3.73
Differences between pairs	1.		1.30**	2.14**
	2.			.84**
$S_{\bar{A}} = .18$			r_2	r_3
q .95			2.80	3.36
q .99			3.70	4.20
$S_{\bar{A}}q$ .95			.40	.60
$S_{\bar{A}}q$ .99			.66	.75

*$p < .05$

**$p < .01$

CATEGORIES OF
ANALYTIC QUESTIONS - TEACHING SESSION 3

Treatment Groups		1. Control	2. Written	3. Film Mediated
Ordered Means		1.33	2.98	3.84
Differences between pairs	1.		1.65**	2.51**
	2.			.86**
$S_{\bar{A}} = .18$			r_2	r_3
q .95			2.80	3.36
q .99			3.70	4.20
$S_{\bar{A}}q$ .95			.40	.60
$S_{\bar{A}}q$ .99			.66	.75

$^{*}p < .05$

$^{**}p < .01$

HIGH QUALITY

ANALYTIC QUESTIONS - TEACHING SESSION 2

Treatment Groups		1. Control	2. Written	3. Film Mediated
Ordered Means		1.92	5.18	9.90
Differences between pairs	1.		3.26**	7.98**
	2.			4.72**
$S_{\bar{A}} = .57$			r_2	r_3
q .95			2.80	3.36
q .99			3.70	4.20
$S_{\bar{A}}q$ .95			1.60	1.92
$S_{\bar{A}}q$ .99			2.11	2.39

*$p < .05$

**$p < .01$

HIGH QUALITY

ANALYTIC QUESTIONS - TEACHING SESSION 3

Treatment Groups		1. Control	2. Written	3. Film Mediated
Ordered Means		1.68	6.73	10.15
Differences between pairs	1.		5.05**	8.47**
	2.			3.42**
$S_{\bar{A}} = .57$			r_2	r_3
q .95			2.80	3.36
q .99			3.70	4.20
$S_{\bar{A}}q$ .95			1.60	1.92
$S_{\bar{A}}q$ .99			2.11	2.39

*$p < .05$

**$p < .01$

NONANALYTIC QUESTIONS - TEACHING SESSION 2

Treatment Groups		1. Film Mediated	2. Written	3. Control
Ordered Means		16.02	19.13	25.40
Differences between pairs	1.		3.11	9.38**
	2.			6.27**
$S_{\bar{A}} = 1.61$			r_2	r_3
q .95			2.80	3.36
q .99			3.70	4.20
$S_{\bar{A}}q$ 95			4.51	5.40
$S_{\bar{A}}q$ .99			5.96	6.76

*p < .05

**p < .01

NONANALYTIC QUESTIONS - TEACHING SESSION 3

Treatment Groups		1. Film Mediated	2. Written	3. Control
Ordered Means		15.51	16.24	25.96
Differences between pairs	1.		1.73	10.45**
	2.			8.72**
$S_{\bar{A}} = 1.61$			r_2	r_3
q .95			2.80	3.36
q .99			3.70	4.20
$S_{\bar{A}}q$ .95			4.51	5.40
$S_{\bar{A}}q$ .99			5.96	6.76

$*p < .05$

$**p < .01$

APPENDIX J

TESTS ON MEANS USING NEWMAN-KEULS PROCEDURE WRITTEN MEASURES

MATCHING TEST

Treatment Groups		1. Control	2. Written	3. Film Mediated
Ordered Means		7.03	9.77	10.71
Differences between pairs	1.		2.74**	3.68**
	2.			.94*
$S_{\bar{A}} = .33$			r_2	r_3
q .95			2.80	3.36
q .99			3.70	4.20
$S_{\bar{A}}q$ .95			.92	1.10
$S_{\bar{A}}q$ .99			1.22	1.40

*$p < .05$

**$p < .01$

TRUE-FALSE TEST

Treatment Groups		1. Control	2. Written	3. Film Mediated
Ordered Means		7.90	10.67	11.83
Differences between pairs	1.		2.77**	3.93**
	2.			1.16
$S_{\bar{A}} = .44$			r_2	r_3
q .95			2.80	3.36
q .99			3.70	4.20
$S_{\bar{A}}q$ .95			1.23	1.48
$S_{\bar{A}}q$ .99			1.60	1.85

*$p < .05$

**$p < .01$

APPENDIX K

INTERCORRELATIONS OF ABILITY MEASURES

INTERCORRELATIONS OF ABILITY MEASURES: FILM-MEDIATED MODELING GROUP

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1. Hidden Figures - Part I		59	90	43	32	39	40	43	45	32	08	18	03	13	10	31	-13	25	10	19	07	15	13
2. Hidden Figures - Part II			87	31	30	33	29	38	37	22	09	16	18	23	22	24	04	19	02	13	07	30	22
3. Hidden Figures - Total				42	35	40	39	46	46	31	09	20	11	20	18	31	-05	25	08	18	08	25	20
4. Identical Pictures - Part I					65	83	41	49	48	24	13	20	32	33	34	32	-05	22	37	34	07	14	12
5. Identical Pictures - Part II						93	40	48	48	09	18	15	21	34	29	25	00	07	23	17	-02	09	04
6. Identical Pictures - Total							46	54	54	20	19	22	29	37	34	32	-01	12	26	22	-01	09	05
7. Maze Tracing - Part I								72	91	18	02	12	25	25	26	40	09	14	17	21	00	-03	-02
8. Maze Tracing - Part II									93	36	26	35	37	25	33	36	00	-01	17	10	-15	-13	-15
9. Maze Tracing - Total										30	16	27	34	27	32	41	04	05	18	16	-09	-09	-10
10. Word Arrangement - Part I											68	88	46	29	39	33	10	24	29	28	08	15	14
11. Word Arrangement - Part II												93	53	40	48	36	00	09	27	22	-03	12	06
12. Word Arrangement - Total													56	39	49	39	04	17	30	28	04	14	11
13. Advanced Vocabulary - Part I														82	94	67	00	21	28	32	23	23	25
14. Advanced Vocabulary - Part II															95	69	00	30	26	35	33	38	39
15. Advanced Vocabulary - Total																72	08	27	28	35	29	32	34
16. Verbal GRE																	00	26	22	32	31	25	29
17. Film Memory																		28	41	35	13	11	13
18. Memory for Ideas - Part I																			69	91	59	67	69
19. Memory for Ideas - Part II																				89	40	44	46
20. Memory for Ideas - Total																					55	60	63
21. Sentence Reproduction - Part I																						68	88
22. Sentence Reproduction - Part II																							94
23. Sentence Reproduction - Total																							

Decimals omitted.

INTERCORRELATIONS OF ABILITY MEASURES: WRITTEN MODELING GROUP

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1. Hidden Figures - Part I		50	86	18	36	29	26	32	31	25	14	20	19	24	22	17	13	02	-04	01	-19	02	-14
2. Hidden Figures - Part II			87	27	48	42	14	20	19	26	15	24	20	14	19	08	32	25	13	25	-06	-01	-09
3. Hidden Figures - Total				26	49	41	23	30	29	29	17	25	23	22	23	14	26	16	05	15	-14	00	-13
4. Identical Pictures - Part I					75	90	33	31	34	26	25	25	35	26	33	19	-05	37	21	35	31	21	26
5. Identical Pictures - Part II						93	41	42	45	21	27	24	37	32	37	27	11	29	15	26	22	12	15
6. Identical Pictures - Total							43	41	45	26	29	28	42	31	39	30	02	37	18	33	26	17	21
7. Maze Tracing - Part I								72	91	10	32	22	11	28	23	31	03	02	24	67	17	25	21
8. Maze Tracing - Part II									94	09	23	19	26	34	33	22	01	-04	08	-01	23	26	24
9. Maze Tracing - Total										10	29	22	20	34	31	28	02	-01	16	03	21	28	25
10. Word Arrangement - Part I											73	90	-07	-01	-05	06	18	15	11	19	13	02	05
11. Word Arrangement - Part II												94	-02	07	01	07	04	18	06	-16	16	10	10
12. Word Arrangement - Total													-06	03	-02	06	11	15	06	15	15	07	09
13. Advanced Vocabulary - Part I														77	93	39	-15	00	03	-03	25	-02	09
14. Advanced Vocabulary - Part II															93	42	-01	-03	06	-04	32	13	22
15. Advanced Vocabulary - Total																43	-08	00	06	-02	29	08	18
16. Verbal GRE																	-06	01	03	00	25	31	36
17. Film Memory																		17	20	30	-13	-12	-16
18. Memory for Ideas - Part I																			32	92	20	12	16
19. Memory for Ideas - Part II																				59	22	-03	07
20. Memory for Ideas - Total																					23	07	14
21. Sentence Reproduction - Part I																						43	84
22. Sentence Reproduction - Part II																							81
23. Sentence Reproduction - Total																							

Decimals omitted.

INTERCORRELATIONS OF ABILITY MEASURES: CONTROL GROUP

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1. Hidden Figures - Part I		73	93	31	30	33	27	09	19	18	05	11	-02	08	03	00	-15	-05	-20	-13	13	-05	02
2. Hidden Figures - Part II			92	41	51	49	30	28	32	24	15	18	-13	02	-04	-02	-05	-04	00	-02	-01	-09	-07
3. Hidden Figures - Total				39	43	44	31	19	27	22	11	16	-08	05	00	00	-11	-05	-11	-08	06	-07	-02
4. Identical Pictures - Part I					74	92	40	49	48	12	15	15	11	34	26	37	-02	00	03	00	15	27	26
5. Identical Pictures - Part II						92	48	48	51	-07	11	06	17	33	28	27	07	-05	10	01	11	22	21
6. Identical Pictures - Total							47	52	53	-01	15	06	15	38	30	34	05	00	10	04	14	29	27
7. Maze Tracing - Part I								80	94	-05	-02	-03	-10	11	01	29	42	25	16	25	10	08	11
8. Maze Tracing - Part II									94	01	11	08	-19	02	-07	20	37	25	16	25	04	03	04
9. Maze Tracing - Total										-02	04	01	-15	06	-03	26	41	27	17	26	06	05	07
10. Word Arrangement - Part I											66	89	-04	00	-02	08	12	37	21	25	00	02	01
11. Word Arrangement - Part II												91	01	06	04	14	14	41	23	39	-07	00	-03
12. Word Arrangement - Total													-01	06	03	16	14	43	14	35	-01	03	01
13. Advanced Vocabulary - Part I														75	92	50	13	-01	-01	-01	25	54	50
14. Advanced Vocabulary - Part II															95	68	25	00	-01	00	32	46	47
15. Advanced Vocabulary - Total																64	21	-01	-01	-01	31	53	52
16. Verbal GRE																	23	02	12	07	27	41	41
17. Film Memory																		46	44	52	08	17	16
18. Memory for Ideas - Part I																			50	91	-07	14	06
19. Memory for Ideas - Part II																				81	02	00	01
20. Memory for Ideas - Total																					-03	10	05
21. Sentence Reproduction - Part I																						42	77
22. Sentence Reproduction - Part II																							90
23. Sentence Reproduction - Total																							

Decimals omitted.

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